DETERMINANTS OF INFORMATION AND COMMUNICATION TECHNOLOGY INTEGRATION IN LEARNING OF NUMERACY CONCEPTS IN LOWER PRIMARY SCHOOLS IN MOMBASA COUNTY, KENYA

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A RESEARCH THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY (EARLY CHILDHOOD STUDIES) IN THE SCHOOL OF EDUCATION, KENYATTA UNIVERSITY

SEPTEMBER, 2018
DECLARATION

I confirm that this research thesis is my original work and has not been presented in any other university/institution for certification. The thesis has been complemented by referenced works duly acknowledged. Where text, data, graphics, pictures or tables have been borrowed from other works- including the internet, the sources are specifically accredited through referencing in accordance with anti-plagiarism regulations.

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DEDICATION

I dedicate this thesis to my children Ramon and Natalie. They had to contend with living mostly without father’s attention at a time they needed him the most. This study was conducted when they were at their most tender age.
ACKNOWLEDGEMENT

First and foremost, I would like to thank the Almighty God for His grace and favour that has enabled me to complete this thesis. All praise is due to God for the success He has granted me. My deepest gratitude goes to my able supervisors, Dr. Teresa Mwoma and Dr. Catherine Murungi who provided me invaluable time, expertise, guidance, encouragement and priceless advice throughout the entire period. Without you I wouldn’t have made it this far. I would also like to appreciate Dr. Begi’s expertise, guidance, advice and insights in the course of this study. My thanks also go to all the lecturers in the Department of Early Childhood Studies for their kind advice. My sincere gratitude goes to Angela for her support in facilitating the movement of thesis drafts between myself and the supervisors. My sincere gratitude also goes to all the head teachers who facilitated data collection exercise in their various schools. Furthermore, I would like to appreciate all the teachers who co-operated and shared information with me on the use of ICT in their teaching of numeracy concepts. The information they shared gave me a lot of insights useful in answering research questions and subsequently enabled me to complete writing this thesis. Further, I would like to appreciate the technical assistance I received from Gregory in formatting the thesis.

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### ABBREVIATIONS AND ACRONYMS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>ANOVA</td>
<td>Analysis of Variance</td>
</tr>
<tr>
<td>BECTA</td>
<td>British Education and Communication Technology Agency</td>
</tr>
<tr>
<td>BFR</td>
<td>Break From Routine</td>
</tr>
<tr>
<td>CCT</td>
<td>Connected Classroom Technology</td>
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<td>CFSK</td>
<td>Computer for Schools Kenya</td>
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<tr>
<td>DLP</td>
<td>Digital Learning Programme</td>
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<tr>
<td>EFA</td>
<td>Free Primary Education</td>
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<td>EPDC</td>
<td>Education Policy and Data Centre</td>
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<tr>
<td>FCA</td>
<td>Facilitate Classroom Activity</td>
</tr>
<tr>
<td>GOK</td>
<td>Government of Kenya</td>
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<tr>
<td>ICT</td>
<td>Information and Communication Technology</td>
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<td>ICTs</td>
<td>Information and Communication Technologies</td>
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<td>ILS</td>
<td>Interactive Learning Styles</td>
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<tr>
<td>IPC</td>
<td>Increase Pupil Concentration</td>
</tr>
<tr>
<td>IPE</td>
<td>Increase Pupil Engagement</td>
</tr>
<tr>
<td>ITU</td>
<td>International Telecommunication Union</td>
</tr>
<tr>
<td>KICD</td>
<td>Kenya Institute of Curriculum Development</td>
</tr>
<tr>
<td>MBA</td>
<td>Mathematics Becomes Attractive</td>
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<tr>
<td>NEPAD</td>
<td>New Partnerships for African development</td>
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<tr>
<td>NCTM</td>
<td>National Council of Teachers of Mathematics</td>
</tr>
<tr>
<td>NDLP</td>
<td>National Digital Literacy Programme</td>
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<tr>
<td>OP</td>
<td>Observation Protocol</td>
</tr>
<tr>
<td>PC</td>
<td>Personal Computer</td>
</tr>
<tr>
<td>PD</td>
<td>Professional Development</td>
</tr>
<tr>
<td>PLA</td>
<td>Promote Learner Autonomy</td>
</tr>
<tr>
<td>PTR</td>
<td>Pupil Teacher Ratio</td>
</tr>
<tr>
<td>RPA</td>
<td>Raise Pupil Attention</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>RPW</td>
<td>Reduce Pupil Weakness</td>
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<tr>
<td>TIP</td>
<td>Teacher Interview Protocol</td>
</tr>
<tr>
<td>TPACK</td>
<td>Technological Pedagogical and Content Knowledge</td>
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<tr>
<td>TSC</td>
<td>Teachers’ Service Commission</td>
</tr>
<tr>
<td>TTA</td>
<td>Teacher Training Agency</td>
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<tr>
<td>TQ</td>
<td>Teacher Questionnaire</td>
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<tr>
<td>UNESCO</td>
<td>United Nations Educational Scientific and Cultural Organization</td>
</tr>
<tr>
<td>USA</td>
<td>United States of America</td>
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<tr>
<td>WSIS</td>
<td>World Summit of Information Society</td>
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ABSTRACT
This study explored how teachers use ICT in their teaching of numeracy concepts to children in lower grades. The study also examined factors that enhance or hinder teachers’ use of ICT in teaching numeracy skills. Literature reviewed revealed that there is generally poor performance in mathematics among pupils. This could be attributed to inadequate development of basic mathematics concepts in the lower grades. Findings from previous studies indicate that ICT has great potential in enhancing the teaching of mathematics. It was envisaged in this study that the findings would provide valuable insights that would help improve the teaching and learning of numeracy concepts through the use of ICT. An exploratory sequential mixed methods research design was employed to conduct the study in which quantitative data was initially collected in the first phase. Qualitative data was then collected in the second phase to explain the quantitative data. The study targeted all the teachers teaching in lower grades in both private and public primary schools in Mombasa County, Kenya. A sample of 40 primary schools was purposively selected based on the availability of ICT tools for instructional purposes. Three teachers teaching in lower grades (Grades 1, 2 & 3) were then selected from each school. In cases where there were more than three teachers teaching in lower grades in a school, simple random sampling technique was employed to select only three. The sample size selected comprised of 25% of all the lower primary schools in the county. Teacher Questionnaire (TQ), Teacher’s Interview Protocol (TIP) and Observation Protocol (OP) were used to collect data. Pilot study was conducted in two schools to check and improve these instruments. Validity of the instruments was established through expert reviews and instrument triangulation. Reliability of the instruments was further determined through the use of test-retest technique. The Teacher Questionnaire with a correlation coefficient of \( r = .86 \) was found to be reliable. The Statistical Package for Social Sciences (SPSS) was utilized to prepare and analyze data and to test significance levels between variables at .05 significance level. Data was analyzed statistically using both descriptive and inferential statistics. One Way ANOVA and Pearson Product Moment Correlation Coefficient techniques were utilized to test the hypotheses. Data was also analyzed qualitatively using descriptive phenomenological analysis in which data transcriptions were categorized into themes and sub-themes related to phenomena under study. The findings of the study revealed that only 17% of teachers used ICT in teaching numeracy concepts. The findings further revealed that only a paltry 4% of the teachers used ICT on a regular basis to teach numeracy concepts. It was therefore concluded that teachers’ use of ICT in teaching numeracy concepts in lower primary schools was inadequate. The study findings also revealed that majority of teachers in the schools were inadequately equipped to teach numeracy concepts using ICT. The study findings further revealed that accessibility to laptops and tablets by teachers and learners in schools resulted in increased use of ICT in teaching numeracy concepts. Finally, teachers’ professional development in the use of ICT was found to be a vital ingredient in the effective use of ICT in teaching numeracy concepts. It was recommended that schools should be equipped adequately with ICT resources with a lot of emphasis laid on provision of laptops and tablet for teaching-learning purposes. Additionally, teachers should be given sufficient technical support in their use of ICT in teaching. Finally, it was recommended that teachers should be supported in the course of their professional development in the use of ICT in teaching mathematics.
CHAPTER ONE

INTRODUCTION AND CONTEXT OF THE STUDY

1.1 Introduction

This chapter entails background to the study, statement of the problem, purpose of the study, objectives, research questions, hypotheses, significance, limitations and delimitations. It also focuses on assumptions of the study, theoretical and conceptual frameworks and finally operational definitions of terms.

1.2 Background to the Study

Mathematics is one of the most essential and useful subjects in the school curriculum (Wanjala, Aurah & Symon, 2015). This argument is supported by the position mathematics holds in most school curriculums around the world. For example, in Kenya as in many other countries, mathematics is a core competency both at the elementary and high school levels. Davies and Hersh (2012) view mathematics as an important subject not only for academic purposes, but also as a precursor for future occupation irrespective of which career path individuals may choose to undertake. Mefor (2014) summed it all up by affirming that mathematics relates to everything in the universe from the smallest to the largest.

Burghes (2012) argues that the development of a high level of mathematics proficiency among learners is one of the most important aspirations of education in the 21st century. This is because competency in mathematics is very vital in the understanding and
development of science and technology as well as social sciences. There are however problems in developing successful education systems that effectively support children's development of mathematics competency (Burghes, 2012). In fact many learners possess low confidence levels in mathematics, thereby hindering them from acquiring the necessary mathematics capabilities (Ku, Chen, Wu, Lao & Chan, 2014). Nur (2010) argues that mathematics competencies are essential for life, yet students' performance in mathematics in general at the global scale is significantly low. What factors are responsible for poor performance in mathematics among learners?

Tshabalala and Ncube (2013) elucidate a number of reasons causing dismal performance by learners in mathematics. One of the reasons cited is shortage of well trained teachers. They argue that majority of teachers in schools are not adequately trained to effectively teach mathematics. Other reasons they cited include lack of adequate teaching and learning facilities, poor quality textbooks, crowded classrooms and lack of motivation among teachers. These factors hinder effective acquisition of mathematics competencies among the learners in school. Furthermore, Ojimba (2012) attributes the poor performance in mathematics by learners to acute shortage of qualified teachers, poor mastery of mathematics concepts by most teachers, negative attitude towards mathematics by learners and inadequate teaching and learning facilities in schools. Ojimba (2012) also notes that there is undue emphasis on the coverage of the mathematics syllabus at the expense of meaningful teaching and learning resulting in inadequate acquisition of mathematics competencies among learners. In addition, Sa'ad, Adamu and Sadiq (2014) study found that students' negative attitude towards
mathematics, anxiety and fear of mathematics, poor teaching methods and inadequate teaching and learning materials were the major factors contributing colossally to the poor performance in mathematics by learners.

The Teacher Training Agency [TTA] of England (1999) argues that Information and Communication Technology (ICT) has great potential in making significant contributions to effective development of mathematics competencies among learners. The TTA (1999) explains a number of ways in which ICT supports teaching and learning of mathematics. First, the TTA observes that ICT enables learners to perform and practice numeracy skills easily. Second, it enables learners to explore, describe and explain patterns that occur in numbers, shapes and space. The TTA notes that through ICT, learners are able to manipulate numbers and objects thereby learning their properties. Third, ICT helps learners to develop logical thinking which is very helpful in solving mathematics problems. Fourth, ICT provides immediate feedback which is important in helping learners make progress in learning mathematics; Fifth, ICT enables learners to make multiple connections within and across mathematics concepts. And finally, ICT stimulates mental imagery and helps learners to build up simple mathematical operations. Chrysanthou (2008) further argues that ICT has great potential in making the teaching and learning of mathematics a pleasurable experience. The National Council of Teachers of Mathematics [NCTM] of the United States (2000) developed six principles of effective teaching of mathematics in school. The use of ICT in teaching mathematics was identified by the NCTM (2000) as one of the six key principles of effective teaching of mathematics. The NCTM argues that it is of paramount importance for teachers and
learners to be allowed to have regular access to ICT tools that support and advance mathematical sense making, reasoning, problem solving, and communication.

According to Oldknow and Taylor (2000) there are at least three reasons for integrating ICT into the teaching and learning of mathematics; namely, desirability, inevitability and public policy requirements. On desirability, ICT motivates, encourages and stimulates learners in their learning of mathematics. As for the teacher, ICT helps to improve the teacher's efficiency in the teaching mathematics. The use of ICT also makes the teacher to be less administrative during mathematics instruction. Therefore it allows the teacher more time to focus on students' work and enable him/her to develop better assessment strategies of evaluating learners' progress in mathematics. On the inevitability of ICT, Oldknow and Taylor (2000) argue that sometimes ICT becomes inevitable for teaching and learning of mathematics competencies particularly when there exists no alternative conventional methods of effectively teaching mathematics. Furthermore, the NCTM (2000) asserts that ICT has the ability to transform abstract mathematical concepts into concrete, visual representations that children can easily grasp. This is particularly essential in teaching mathematics in lower grades where children may not be developmentally ready to deal with abstract mathematics concepts. The NCTM (2000) further argues that children's engagement with abstract mathematical concepts can be encouraged through the use of appropriate ICT tools. For that reason, it is imperative to provide learners with appropriate ICT tools to buttress their development of mathematics competencies and more so prop up their level confident.
The British Education and Communication Technology Agency [BECTA] (2003) draws attention to a number of key benefits of using ICT in the teaching mathematics. First, BECTA stresses that ICT leads to increased collaboration between pupils. It also leads to increased focus on strategies of mathematics and provides fast and accurate feedback resulting in increased level of motivation among learners. Secondly, ICT tools are embedded with interactive multimedia features which motivate learners consequently leading to improved performance in mathematics. And thirdly, ICT tools provide learners with superior communication tools that allow them to use graphics, images, sound and text to learn and exhibit mathematical competency. To what extent do teachers in Mombasa, Kenya use ICT to motivate and enhance development of numeracy skills?

Drijvers, Doorman, Boon, Reed and Gravemeijer (2010) identified six ICT instrumental orchestration techniques used during a mathematics learning session. Drijvers et al (2010) defines ICT orchestration techniques as teacher's intentional and systematic organization and use of various ICT resources in a classroom environment in any given mathematics activity. The six orchestration techniques identified were as follows: First was the technical-demo orchestration technique which involves the teacher projecting information on an ICT screen during a mathematics lesson in which learners were allowed to follow the teacher's demonstrations on that screen.

Second technique was explain-the-screen orchestration in which the teacher explains to the whole class what is happening on a digital screen that is projected for the entire class to see. Third technique was link-the-screen orchestration in which the teacher emphasizes the link between information presented on a digital screen and how the same information
could be presented in a conventional learning environment of using textbooks and on the chalkboard. In this technique both the chalkboard and digital screen are clearly made visible to all the learners as they work through the on-going mathematics activities. The fourth technique was discuss-the-screen orchestration which involves the whole class discussing the content displayed on a digital screen. Drijvers et al (2010) argue that discussions that are held in an ICT environment are more productive than those done in the traditional chalkboard and textbook learning environment. This is because in an ICT environment, suggestions for different representations and techniques as they emerge in the discussions could easily be tried out with fast and dynamic feedback.

The fifth technique that was identified by Drijvers et al (2010) was spot-and-show orchestration technique. In this technique, a unique mathematical reasoning by a particular student is creatively utilized by the teacher for the benefit of other learners. This is done by the teacher identifying and deliberately using this particular learner’s work for the purposes of class discussion. The sixth technique to be identified by Drijvers and his colleagues was Sherpa-at-work orchestration technique. In this technique, a typical student referred to as Sherpa, uses ICT to carry out the teacher’s instructions in solving mathematics problems. This technique calls for organization of the classroom settings in such a way that a student (in this case referred to as Sherpa) is in control of using ICT, with all other students being able to follow Sherpa and the teacher easily. Sherpa could be any of the learners in the classroom during a mathematics lesson. What ICT orchestration techniques do teachers in Kenya, particularly those in Mombasa use to teach numeracy concepts?
Drijvers (2012) investigated factors that promote or hinder successful use of ICT in teaching mathematics in Seol, Korea. Three factors emerged from this study as very critical when using ICT to teach mathematics. First and foremost, the design of ICT tools and that of the corresponding learning activities meant to augment development mathematics competencies. Drijvers (2012) argue that pedagogical functionality of ICT devices should be put into consideration when designing mathematics learning activities. If this is not properly done, effective development of mathematics competencies is bound to fail. The second most important factor to be considered is the role the teacher plays in the use of ICT in teaching mathematics. Drijvers (2012) argue that the use of ICT in the learning process is not a panacea that reduces the significance of the teacher during classroom instruction. He asserts that the teacher’s main role is to orchestrate learning by creating a rich ICT environment for learning mathematics. The role of the teacher is also to highlight suitable ICT techniques and relate ICT experiences to paper-and-pencil learning activities (Drijvers, 2012).

Professional development of teachers is therefore a critical component in the successful implementation of ICT use in teaching mathematics. Mishra and Koehler (2006) argue that an effective mathematics teacher should possess knowledge of mathematics concepts with profound understanding of what is good for effective use of ICT in teaching. According to Mishra and Koehler (2006) effective mathematics teachers are those who consolidate knowledge of subject matter (mathematics concepts), strategies for learning (pedagogy) and technology (ICT) in the teaching and learning process. The combination of the above three afore mentioned components lead to the development of a special kind
of knowledge referred to as Technological, Pedagogical and Content Knowledge (TPACK). Furthermore, Mishra and Koehler (2006) maintain that every mathematics teacher must possess TPACK in order to effectively use ICT in teaching mathematics. TPACK is more than simply including basic ICT skills to traditional techniques of teaching mathematics. It is founded upon deep understanding of how ICT could be harnessed to sustain and enhance development of mathematics competencies. The extent to which primary school teachers in Mombasa, Kenya possess TPACK for effective use ICT in teaching numeracy concepts has not been established.

Ku, Chen, Wu, Lao, & Chan (2014) conducted a study in Taiwan to investigate the effects of game-based learning on mathematical confidence and performance among fourth grade high ability and low ability children. The study sought to find out whether learning in a digital-game environment was significantly beneficial to children with various mathematics learning abilities. The results revealed that students who learnt mathematics in a digital game-based programme performed better in mathematics than their counterparts who learnt in a paper-and-pencil environment both in terms students' confidence and scores in a mathematics test.

Ku at al. (2014) argue that low confidence in mathematics was one of the critical reasons that made students perceive mathematics as a difficult subject to study. Such a negative feeling consequently discouraged students in pursuing mathematics (Brown, Brown, & Bibby, 2008). Moreover, Maclellan (2014) argues that self-confidence among children is one of the critical factors that enhance learning of mathematics. Self-confidence was found to be a predictor of learners’ behavior in the classroom in the sense that it
influenced the degree of effort learners made in a learning situation as well as expectations they had on their learning outcomes (Schunk, 1990). Stankov, Lee, Luo, & Hogan (2012) found a strong positive correlation between students’ confidence and their learning of mathematics. Ku et al. (2014) asserts that game-based learning is gradually gaining recognition as a potential means of improving children's confidence in the learning of mathematics. To what extent do teachers in Mombasa use ICT in creating digital game-based learning environment for enhancing children's confidence in numeracy concepts?

Agyei and Voogt (2011) conducted a study in Ghana to explore the feasibility of using ICT in teaching mathematics in senior high school. The study results revealed that mathematics teachers in Ghana did not willingly use ICT tools in teaching mathematics high school. The study also found that lack of knowledge on ways and means of integrating ICT into the teaching of mathematics compounded by the lack of opportunities for teacher training in ICT use were key factors hindering the use of ICT in teaching mathematics. To overcome these barriers, the study suggested that Ghanaian Government should undertake extensive professional development programmes for the teachers. To what extent are teachers in Kenya professionally trained to integrate ICT tools in their teaching of numeracy concepts?

Wanjala, Aurah, and Symon (2015) conducted a study in Bungoma County, Kenya to examine factors that affect integration of computers in the teaching of mathematics in secondary schools. The findings revealed that use of computers for the purposes of teaching and learning mathematics was insignificant. The results further indicated that
most teachers lacked essential computer knowledge and skills necessary for integrating ICT into their pedagogical practice. Teachers were found to be having inadequate expertise required to use computers for teaching mathematics. The study found that teachers' computer knowledge and skills, perceived usefulness of computers in teaching and learning mathematics, access to computer hardware and software, technical support and pedagogical practice of using computers as major factors determining the use of computers in teaching mathematics in secondary schools. Likewise, Mogire (2014) found minimal use of computers in teaching mathematics in the secondary schools in Kisii County, Kenya. The following factors were found to be responsible to this state of affairs: Lack of mathematics software, lack of computer skills among teachers and pupils and inadequate space in computer laboratories. What factors encourage or hinder the use of ICT in the teaching of numeracy concepts in lower primary schools in Mombasa?

In cognizant of the fact that ICT has great potential in enhancing learning, the Kenyan Government rolled out a programme of delivering ICT devices to pupils in all public primary schools (ICT Authority, 2016). The decision to implement the Digital Learning Programme (DLP) in schools was born out of the vision that information technology is currently defining the modern world and there is need to prepare the young for the current realities. Through DLP the Government of Kenya envisioned the creation of smart schools characterized by development and delivery of quality curriculum content, professionally skilled teachers and 21st century learners. According to the ICT Authority (2016) the government had already connected 23,951 public primary schools to the national power grid. Moreover, approximately 79,893 teachers had already been trained on ICT integration skills. The outline for digital content had already been developed and
it could be accessed and downloaded at the following portal: http://kicdinteractivecontent.ac.ke. Furthermore, according to the ICT Authority (2016) the government of Kenya had already distributed 12000 digital devices to 150 primary schools selected for the pilot programme between April 4, 2016 and May 14, 2016. A total of 1.2 million devices were earmarked to be delivered to all the public primary schools in the country. A robust teacher training programme earmarked for the 300 teachers from 150 pilot schools had already been done during the April 2016 school holidays (ICT Authority, 2016). According to ICT Authority (2016) approximately 3 teachers from each of the 23000 public primary schools in the country had been trained on ICT integration in education. Three schools from each county had already been selected for the pilot programme. The extent to which teachers in these schools had integrated ICT into their teaching of numeracy concepts was yet to be established.

Wando (2010) claimed that despite the fact that mathematics is an essential and useful subject in the school curriculum; its performance has not been impressive over the years. Similarly, Uwezo (2012) reported a gloomy picture on the state of children's performance in numeracy skills in the lower primary schools. The report revealed that majority of children in the lower primary schools in Kenya were not developing basic mathematics skills as prescribed in the national school curriculum (Uwezo, 2014). The Report further indicated that children were not acquiring foundational numeracy skills that were consistent with the mathematics curriculum requirements. Uwezo Report (2014) also found that 30% of children in standard three in Kenyan lower primary schools could not perform a simple grade two numeracy problem. The report further found that majority (70%) of standard three pupils in schools at the Coastal region of Kenya could not solve a
standard two numeracy problem involving subtraction. This report therefore implied that majority of children in lower primary schools in Kenya cannot solve simple mathematics problems. This could also imply that basic mathematics concepts are not adequately developed at the lower primary school level. There was therefore need to seek ways and means of improving children's performance in numeracy concepts in lower primary schools.

Wanjala et al. (2015) asserted that majority of teachers in Kenya have continued to use traditional methods of instruction to teach mathematics. Wanjala et al (2015) further argue that traditional teaching approaches whereby teachers are the ultimate sources of knowledge while students passively receive and record this knowledge in memory are not effective anymore. There is therefore urgent need to transform mathematics learning sessions into learner-centred milieu augmented with meaningful activities that promote efficient teaching and learning. However, despite the great potential of ICT in enhancing teaching and learning of numeracy concepts, its integration into classroom instructional practice remains wanting in most schools. Perhaps teaching and learning of numeracy concepts in the lower primary schools could be enhanced by integration of ICT into pedagogical classroom strategies. Wanjala et al (2015) argue that ICT has great potential in teaching mathematics concepts that would otherwise be difficult to teach using traditional approaches where learners’ motivation is considerably low. The current study therefore sought to investigate levels of ICT use in teaching numeracy concepts. It also sought to establish determinants of ICT use for teaching and learning purposes in lower primary schools in Mombasa County.
1.3 Statement of the Problem

Mathematics is one of the most important subjects in the school curriculum. Yet students’ performance in numeracy concepts remains significantly low over the years. This phenomenon has been attributed to inadequately equipped teachers, use of poor strategies of teaching numeracy concepts and inadequate teaching and learning facilities. Literature reviewed shows that ICT has great potential if properly harnessed to make significant positive contributions to effective teaching and learning of mathematics. Drijvers et al. (2010) identified six orchestration techniques employed by teachers in USA in using ICT to teach mathematics. Orchestration techniques used by teachers in the Kenyan context in teaching numeracy concepts using ICT are unknown.

Studies conducted in Kenya on the use of ICT in teaching have mainly focused on secondary schools. There has been limited attention on how ICT is used to teach mathematics in lower primary schools. Furthermore, most studies have mainly focused on examining quantitatively factors hindering use of ICT in teaching. Factors encouraging the use of ICT in teaching numeracy concepts have received very little attention. Pedagogical strategies of teaching numeracy concepts in an ICT environment have also not received much attention in research literature. The current study therefore employed the use of mixed methods approach to capture comprehensive data on how teachers utilized ICT in their development of numeracy concepts. Previous studies have mainly focused on how teachers’ training on basic computer literacy skills influence their use of ICT in teaching. The current study however focused its investigation on a specialized ICT knowledge referred to as Technological, Pedagogical and Content Knowledge (TPACK). It investigated the extent to which teachers were equipped with
TPACK and how this knowledge influenced their use of ICT in teaching numeracy concepts.

In cognizant of the key role played by ICT in enhancing quality of teaching and learning, the Kenyan Government launched the Digital Learning Programme (DLP) in which public primary schools are being equipped with ICT resources. The key components of this programme include teacher training, digital content development and delivery of digital devices to various schools. There was need to examine the extent to which teachers are utilizing these devices in teaching numeracy concepts.

The need for this study was pegged on the premise that the Kenyan Government was exploring ways and means of improving the quality teaching and learning through use of ICT. It was also premised on Uwezo reports (2012) which revealed that children’s performance in basic numeracy skills was wanting. There was therefore need to carry out the current study to establish how ICT could be harnessed to transform teaching and learning of numeracy concepts.

1.4 **Purpose of Study**

The purpose of this study was to explore teachers’ use of ICT tools in teaching numeracy concepts in lower primary schools. The study further sought to establish factors that encourage or hinder teachers’ use of ICT resources in their teaching of mathematics.

1.5 **Objectives of the Study**

The study focused on the following objectives:
a) To establish whether ICT devices were accessible to teachers for use in teaching numeracy concepts in lower primary schools.

b) To establish whether teachers’ use of ICT tools empowered them to teach numeracy skills better.

c) To determine whether teachers’ training on ICT influences their use of ICT in teaching numeracy concepts.

d) To determine the kind of ICT support teachers get in their use of ICT in teaching numeracy concepts.

e) To establish whether ICT influenced teachers’ pedagogical practices in teaching numeracy concepts.

f) To examine factors that encourage or hinder teachers’ use of ICT in teaching numeracy concepts.

1.6 Research Questions

The research questions included the following:

i. Which ICT devices are accessible to teachers for use in teaching numeracy concepts in lower primary schools?

ii. How do ICT tools empower teachers to teach numeracy concepts better?

iii. How does training on ICT influence teachers’ use of ICT in teaching numeracy concepts?
iv. What kind of ICT support do teachers get in their use of ICT in teaching numeracy concepts?

v. How does the use of ICT in teaching numeracy concepts influence teachers’ pedagogical practices in the classroom?

vi. What factors encourage or hinder teachers’ use of ICT in teaching numeracy concepts?

1.7 Research Hypotheses

The hypotheses for the study were:

Hₐ1: There is a significant difference in the means of using ICT in teaching numeracy concepts between teachers who have access to ICT tools and those who do not have any access.

Hₐ2: There is a significant relationship between teachers’ training on ICT and their use of ICT in teaching numeracy concepts.

Hₐ3: There is a significant difference in the means of using ICT in teaching numeracy concepts between teachers who receive support in use of ICT and those who do not receive any support.

1.8 Assumptions of the Study

This study was carried out based on the following assumptions. That:

- Teachers had access to ICT resources at school which could have been personally owned or provided by the school either for official, instructional or personal use.
• The teachers would report, honestly, truthfully and accurately about their use of ICT in the teaching of numeracy concepts.

• The kind of ICT training teachers underwent largely depended on the place of training. For example, in commercial colleges teachers mainly learnt basic ICT literacy skills while government sponsored seminars and workshops, teachers mainly learnt strategies for using ICT in teaching numeracy concepts.

1.9 Limitations of the Study

In this study, the main limitation was the use of teachers’ self-reports in the Teacher Questionnaire (TQ) which was used to measure their level of use of ICT in teaching numeracy concepts. However to mitigate the effect of this limitation, the information generated from the TQ was triangulated through use of interview and observation methods. The researcher observed mathematics lessons of teachers who had indicated that they used ICT in teaching numeracy concepts. These teachers were later on interviewed after lesson presentation to corroborate and shade more light on data gathered from questionnaire and lesson observation.

1.10 Delimitations of the Study

This study only focused on the use of ICT in teaching numeracy concepts in lower primary schools in Mombasa County. The findings of the study therefore may only be generalized to the influence of ICT in teaching numeracy concepts in lower primary. The influence of ICT in teaching other curriculum areas such as languages, social studies, creative, science, religious studies, life skills and music may form basis for future studies.
The focus of the current study on lower primary schools was prompted by the government’s intention to implement Digital Learning Programme (DLP) in all public primary schools in order to improve quality of learning, beginning with the lower primary schools. The current study was only confined to Mombasa County owing to financial and time constraints. It would not have been possible to cover the entire country in order to provide the national outlook desired. Therefore, the findings of the current study might only be generalized to the use of ICT in teaching numeracy concepts in the lower primary schools in Mombasa County.

1.11 Significance of the Study

The findings of this study might be useful to a number of key stakeholders in the education sector, particularly the primary school education sub-sector. First, the study results might provide useful data and information for teacher training, at college and university levels of education. This is because the study revealed that there were gaps in ICT competency skills necessary for effective integration of ICT in classroom instruction. The study further revealed that majority of the teachers possessed only basic ICT skills but lacked the requisite competencies for pedagogical use of ICT in teaching. Acquisition of technological, pedagogical and content knowledge by teachers was found to be a useful ingredient in the use of ICT in teaching numeracy concepts. Professional teacher development in the use of ICT in teaching and learning processes was deemed a necessary step in the right direction.

Second, the findings of this study might provide valuable information on the status of ICT use in teaching numeracy concepts in lower primary schools. This could be of much
interest to organizations such as ICT Authority and NEPAD whose main agenda is to provide support to schools in their quest for integration of ICT into teaching-learning processes. Third, the findings of the study might be helpful to the Kenya Institute of Curriculum Development (KICD) in its developing of e-content (e-curricula) for primary school mathematics. Fourth, the findings of the study might also serve as foundational information for use by educational research community in conducting further research in the area of ICT integration in education. Finally, the findings of this study may provide the Ministry of Education, Science and Technology with useful data on factors that encourage or hinder teachers’ use of ICT in the delivery of the school curriculum. Moreover, the information provided in this study might be crucial to the Kenyan Government as it rolls out Digi School Program in all the public primary schools across the country.

1.12 Theoretical Framework

This study was anchored on the theoretical underpinnings by Mishra and Koehler. Mishra and Koehler (2006) argue that a theoretical framework plays an important role in the research process by guiding the kind of questions asked, the nature of evidence collected, strategies used to analyze data and interpretations derived from data analysis. Therefore, the choice of an appropriate theoretical framework is a pre-requisite for a good research study. The study was grounded on Technological Pedagogical and Content Knowledge (TPACK) Theory proposed by Koehler and Mishra (2005). The study was also grounded on the Theory of Didactical Functions of Technology in Mathematics Education postulated by Drijvers, Boon, and Van Reeuwijk (2010). These two theories did not only
provide insights into the nature of study variables but also demonstrated the complex relationship that exists between variables in the study.

1.12.1 Technological Pedagogical and Content Knowledge (TPACK) Theory

TPACK theory was developed by Koehler and Mishra (2005) as a framework for describing teachers’ body of knowledge required for effective use ICT in teaching. According to this theory, teachers need technological, pedagogical and content knowledge rather than simply acquiring basic computer literacy skills in order to effectively use ICT in their teaching (Mishra & Koehler, 2006). According to this theory, effective teachers require knowledge of the subject matter with profound understanding of what is good for learning using ICT. This theory demonstrates the complex interrelationships among the different elements, and it elucidates how teachers’ understanding of ICT, pedagogy, and content can interact with one another to produce effective mathematics teaching strategy (Shin, Koehler, Mishra, Schmidt, Baran, & Thompson, 2009). This theoretical framework was pegged on the understanding that teaching is a highly complex activity that draws from many kinds of knowledge (Mishra and Koehler, 2006). The theory was also developed based on the understanding that teaching is a cognitive skill that occurs in an ever-changing environment.

Koehler and Mishra (2005) define TPACK as the connections and interactions between content knowledge (numeracy concepts), pedagogical knowledge (how to teach mathematics), and technological knowledge (how to use ICT to teach mathematics). According to Mishra and Koehler (2006) content knowledge involve mastery of actual subject matter to be taught, in the case of the current study, content knowledge involves
teachers’ mastery of numeracy concepts. Pedagogical knowledge involves teachers’ understanding of all issues of student learning, classroom management, lesson plan development and implementation as well as children’s assessment (Mishra & Koehler, 2006). Technological knowledge involves basic understanding processes and skills required to operate ICT tools. Technological knowledge may include but not be limited to understanding of computer operating systems, basic computer hardware and software, ability to use word processors, spreadsheets, mathematics software, browsers and email.

Mishra and Koehler (2006) argue that ICT is ever-changing and therefore the nature of teachers’ technological Knowledge should be revised regularly in order to keep abreast with current technological innovation. Nevertheless, Mishra and Koehler (2006) argue that TPACK is a combination of the three forms of knowledge discussed above. Moreover, they argue that TPACK is an emergent form of knowledge that goes beyond the three aforementioned components of knowledge. Putnam and Borko (2000) argue that expertise teaching is dependent on the teachers’ flexible access to highly organized and dynamic systems of knowledge and skills. Fig. 1.1 shows the diagrammatical representation of the TPACK with its various knowledge components.

![Diagrammatical representation of Technological Pedagogical and Content Knowledge](image)

**Figure 1.1: Diagrammatical representation of Technological Pedagogical and Content Knowledge**

*Source: Mishra and Koehler (2006) pg. 1025*
According to Mishra and Koehler (2006) training teachers on TPACK is the basis of successful and effective use of ICT in teaching and learning process. This is because quality education requires a good understanding of concepts that can be represented using ICT. It also involves good knowledge of pedagogical techniques that utilize ICT in constructive ways to teach mathematics. Furthermore it requires understanding of what makes mathematics concepts difficult or easy to learn and how ICT can be harnessed to address children’s challenges in learning mathematics. This theoretical framework lays emphasis on the significance of teachers acquiring TPACK which is the kind of knowledge necessary for effective use ICT in teaching. According to this theory, good teaching is more than merely adding ICT skills to traditional teaching techniques. Rather, best practice in the teaching mathematics calls for deep understanding of how ICT can be harnessed to enhance learning of mathematics concepts.

According to Swenson, Rozema, Young, McGrail, and Whitin (2005) TPACK revolves around teachers asking themselves questions on how ICT could be used to support and expand effective teaching. The question of what teachers need to know in order to succeed in using ICT to teach has attracted a lot of attention from educational stakeholders and researchers alike (International Society for Technology in Education, 2000). This theory was regarded as pertinent for this study. This is because it was found to be useful in offering analytical lens for understanding the kind of knowledge that teachers required for effective use of ICT in teaching mathematics.
1.12.2 Theory of Didactical Functions of ICT in Mathematics

According to NTCM (2008) ICT is an essential mathematics learning tool in the 21st century. It is therefore imperative that all schools should provide ICT devices for effective teaching and learning of mathematics. However, Drijvers (2012) indicate that stakeholders in education are being confronted with the following fundamental questions:

“How can teachers exploit the potential of ICT in enhancing children’s learning of mathematics? Does ICT enhance teaching of mathematics? And if it does work, what factors are decisive in making it work or in preventing it from working? Does it make learning more effective and efficient?” (Drijvers, 2012; pp2)

These fundamental questions can be explored using the theory of didactical functions of ICT in mathematics instruction. This theory was postulated by Drijvers, Boon, and Van Reeuwijk (2010). According to the theory, there are three main didactical functions of ICT in teaching mathematics. First, ICT has a tool function for doing mathematics, which refers to the outsourcing work done by ICT devices that could also be performed by hand in a paper – and – pencil learning milieu. In this function, ICT performs the work that the hand of the learner does in the process of solving mathematics problems. The second function of ICT is that of providing a conducive learning environment for practicing mathematics skills. Through ICT children are able to develop and practice skills for solving mathematical problems. The third function of ICT is that of providing a stimulating learning environment for developing mathematics concepts. Through ICT, children are able to develop an understanding of numeracy concepts and processes thereof. One key problem why pupils perform poorly in mathematics stems from their failure to grasp basic numeracy concepts. Figure 1.2 depicts a model showing the didactical functions of ICT in the teaching and learning of mathematics. This theory was
considered relevant for this study because it particularly demonstrates mechanisms through which ICT could be harnessed to enhance teaching and learning of mathematics.

**Figure 1.2: Didactical Functions of Technology in Mathematics Education**

*Source: Drijvers, Boon, and Van Reeuwijk (2010) ICT Didactical Functions Model*

1.13 Conceptual Framework

According to the conceptual framework for this study, accessibility to ICT resources by teachers and pupils, TPACK and support to teachers in their use of ICT in teaching were considered as key variables determining teachers’ use of ICT in teaching mathematics. It was proposed in this study that for successful and effective use of ICT in teaching mathematics to take place, teachers need to develop deep understanding of numeracy concepts (content knowledge), pedagogical strategies for teaching numeracy concepts (pedagogical knowledge), and appropriate use of ICT in teaching numeracy concepts (technological knowledge). It is not enough for teachers to simply add basic ICT skills to their traditional teaching strategies. Rather, it is important for them to develop deep understanding of how ICT could be used to enhance teaching and learning of numeracy concepts. Therefore it was proposed that teachers should be imparted with TPACK for successful integration of ICT in the teaching of mathematics.
It was also proposed in this study that teachers’ and pupils’ access to ICT tools and infrastructure was an important determinant in their use of ICT in teaching and learning of mathematics. Teachers can only use ICT in their teaching of mathematics if ICT resources are available at their disposal for instructional purposes. However, availability of ICT tools to teachers does not automatically translate into their use in teaching and learning of mathematics (Hennessy, Harrison & Wamakoti, 2010). It was therefore proposed that a number of factors were responsible for either encouraging or discouraging teachers’ use of available ICT tools in teaching numeracy concepts. Supporting teachers in their use of ICT in the classroom was identified as one major variable that encouraged integration of ICT into the teaching and learning of numeracy concepts. It was further proposed in this conceptual framework that technical support to the teachers in ICT use encouraged their use of ICT in teaching numeracy concepts. Moreover, supporting teachers in pursuit of their professional development in use of ICT in teaching was proposed to be an important enabler in the effective use of ICT in their classroom practice.

Further, in this conceptual framework, it was proposed that use of ICT in the classroom influenced teachers’ pedagogical strategies in the teaching of mathematics thereby impacting on children’s performance in numeracy skills. It was established through literature reviewed that appropriate use of ICT enhanced children’s achievement in numeracy skills. Therefore, the current study treated children’s achievement in numeracy concepts as a non-study variable. Fig. 1.3 shows the conceptual framework for the current study.
**Figure 1.3: Conceptual Framework Model for the Study**

*Source: Researcher’s own work (2018)*

**Key:**
- Study Variables
- Non-study Variable
1.14 Operational Definitions of Key Terms

- **Content knowledge** – refers to teacher’s profound understanding of numeracy concepts taught in lower primary schools.

- **Didactical functions of ICT** – refers to the pedagogical roles that ICT plays in the classroom practice of developing numeracy concepts in children.

- **ICT instrumental orchestration** – refers to techniques adopted by teachers in organizing and using various ICT tools during mathematics learning session.

- **ICT support** – entails the technical and professional assistance teachers get in their use of ICT in teaching numeracy concepts.

- **Information and Communication Technologies** – includes technological devices such as desktop computers, laptops, tablets, digital cameras and projectors. It also includes mathematics software and internet.

- **Pedagogical knowledge** – refers to teacher’s profound understanding of appropriate methods of teaching numeracy concepts in lower primary schools.

- **Pedagogical practices** – all the strategies and activities teachers employ in the teaching of numeracy concepts.

- **Technological knowledge** – refers to teacher’s profound understanding of appropriate methods of using ICT to teach numeracy concepts.
• **Technological Pedagogical and Content Knowledge** – refers to teacher’s profound understanding of skilled teaching of numeracy concepts with the use of ICT tools.
CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter focuses on review of related literature for this study under the following themes: Information and communication technology, availability and use of ICT in teaching mathematics, use of ICT in empowering teachers to teach mathematics better and the level of teachers’ ICT training and knowledge in the use of ICT in teaching mathematics. Literature was also reviewed on how ICT use influences teachers’ pedagogical practices, Support teachers get in use of ICT in teaching mathematics and determinants of use and non-use of ICT in teaching mathematics. The chapter ends with the summary of literature reviewed.

2.2 Information and Communication Technology

Daniels (2002) argues that Information and Communication Technologies (ICTs) have become within a very short time the basic building blocks of contemporary society. According to Noor-Ul-Amin (2013) many countries are focusing on mastering the basic skills and concepts of ICT as part of the goals of education, alongside reading, writing and numeracy. So what does ICT entail? According to United Nations (UN) Report (1999) ICTs cover internet service provision, telecommunications equipment and services, information technology equipment and services, media and broadcasting, libraries and documentation centres, commercial information providers, net-work based information services and other related information and communication activities (UN
Report, 1999; as cited in Noor-Ul-Amin, 2013). United Nations Educational Scientific and Cultural Organization [UNESCO] (2002) describes ICT as the combination of informatics technology with other related technology, particularly communication technology. There is always a misconception that ICTs generally refers to computers and computing related activities.

According to the Kenyan Ministry of Education (2012) ICT integration in education entails incorporation of ICT tools in learning to support and enhance the attainment of appropriate knowledge, skills, attitudes and values and at the same time manage education effectively and efficiently at all the levels of learning. ICT is said to have been effectively incorporated in education when it is used in a smooth manner to support and extend curriculum objectives while at the same time engaging children in meaningful learning activities (Earle, 2002). Noor-Ul-Amin (2013) argues that the use of ICT in classroom instruction helps to revitalize teachers and students alike consequently improving the quality of education by providing curricular support in difficult subject areas. Cabero (2001; as cited in Noor-Ul-Amin, 2013) notes that ICT facilitates flexibilization of time and space during learning thereby increasing classroom interaction and acquisition of construction of knowledge. Therefore, ICT in education acts like a catalyst in the teaching and learning process because it is in itself a source of knowledge as well as a cognitive tool (Noor-Ul-Amin, 2013). The current study sought to examine how teachers used ICT to enhance development of basic mathematics concepts among children in lower primary schools.
2.3 Availability of ICT Devices for Teaching Purposes

Shirley, Irving, Sanalan, Pape and Owens (2011) conducted a study in USA on the implementation of Connected Classroom Technology (CCT). This technology allows students’ work to be projected on a classroom monitor via their calculators. The researchers followed 7 teachers during the school year. The teachers received the necessary equipment to implement CCT in their classrooms. The researchers conducted interviews with the teachers via telephone periodically throughout the school year. They also scheduled classroom observations. The teachers reported they were able to monitor students’ work, give feedback in a quicker time span, and make sure each student was on task (Shirley et al., 2011). Moreover, teachers could immediately see if a student misunderstood a concept as a result of using CCT in the classroom. Remediation and re-teaching could be done immediately in order to get students back on track during the lesson (Shirley et al., 2011). This allowed students to realize their mistakes and seek ways of fixing them as soon as they committed them. In classrooms where CCT was used, students tended to score higher on assessments.

The study found that availability of ICT tools resulted in the successful use ICT in the teaching and learning of mathematics. Norris, Poirot & Soloway (2003) emphasized the importance of access to ICT resources to teachers in facilitating their use in teaching and learning. However, the findings of this study might not apply in the Kenya context owing to socio-cultural and economic differences that exist between study locales. The current study was therefore necessary in order to shade light on the Kenyan context on availability and use of ICT in teaching mathematics in lower primary schools.
Mogire (2013) conducted a study in Kisii, Kenya to examine factors affecting use of computers in teaching and learning of mathematics in secondary schools. The findings of the study revealed that majority of the schools had been inadequately equipped with computers. Further, the study found that there was no software for teaching mathematics. Consequently the study found that computers available in the schools were not used for teaching mathematics but basic computer literacy skills. Lack of computers, support and negative attitudes towards computer use were cited as the major inhibiting factors in the use of ICT for teaching mathematics. Likewise Florida (2011) examined factors affecting integration of ICT in Narok and Bomet counties, Kenya. The study found that only 33% of the schools had been adequately equipped with computers. The study further found that despite the presence of computers in the schools, there was no meaningful integration of ICT in the classroom instruction. Therefore availability of computers in some of the schools did not translate into their use in the teaching-learning process. Hennessy et al (2010) argue that availability of technological tools and infrastructure in the classroom does not in itself improve the quality learning; neither does it automatically increase children’s academic achievement. The studies mentioned above mainly focused on secondary schools. The current study therefore explored the ICT use in the teaching of basic mathematics concepts in the lower primary schools.

2.4 Use of ICT in Enhancing Teaching of Numeracy Concepts

According to NCTM (2008) ICT is an essential mathematics learning tool particularly in this 21st century. It is therefore imperative that all schools ensure that they provide adequate ICT devices to facilitate effective learning of mathematics (Drijvers, 2012).
According to Drijvers (2012) a lot of stakeholders in education and researchers alike are confronted by the question, “Does ICT work in enhancing teaching and learning of mathematics concepts?” A number of studies have been done to examine the influence of ICT in the teaching and learning of mathematics. One of the initial studies conducted to investigate the influence of ICT on the teaching and learning of mathematics was an experimental study done by Heid (1998) in USA.

Heid (1998) conducted an experimental study among first year university students on the use of ICT in teaching mathematics. In this study, calculus concepts were taught to first year university students. The students were also briefly taken through computational skills at the end of the course. The experimental group was exposed to technology-extensive calculus course while the control group attended the same course but in a textbook and chalkboard environment. The experimental group used ICT tools for computational work while the control group performed computational tasks by hand. The results of the study showed that the experimental group performed far much better in a calculus test than the control group. The subjects in the experimental group reported that ICT devices took over the computational tasks leaving them to focus on problem solving skills. Drijvers et al (2010) refers to this phenomenon as the didactical tool function of ICT devices in a mathematical task situation. In addition, the students in the experimental group indicated that the ICT devices enabled them feel more confident in their calculations.
This study was included in the current review of related literature because of its historical significance. It was one of the first leading experimental studies that examined the use of ICT in the teaching and learning of mathematics. This study demonstrated the potential capability of ICT in boosting performance in mathematics among learners. Furthermore, it strongly demonstrated the idea of concept-first approach in teaching mathematics. In this approach, ICT use puts more emphasis on the development of mathematics concepts without undermining development of hand skills during teaching-learning process (Drijvers, 2012). This approach helps the teacher to lay more emphasis on the development of mathematics concepts first.

Ku et al. (2014) conducted a study in United States of America to establish whether game-based learning could affect children confidence and performance in mathematics. The researchers employed an experimental design to carry out this study. In this study, the experimental group learnt mathematics in a digital game-based environment while the control group learnt in a paper-based learning environment. The study found that there was a significant improvement in the level of confidence towards mathematics in students with digital-game-based learning. In contrast, the students in paper-based learning did not significantly improve in their level of confidence towards mathematics. In fact low-ability students in paper-and-pencil learning showed decreased level of confidence towards mathematics. Low confidence among students is one of critical reasons that make mathematics learning a difficult experience. According to Brown, et al. (2008) negative feelings towards mathematics make students get discouraged. Regarding performance, the study found that both students in digital and paper-and-pencil learning
contexts gained significant improvement in mathematics performance, although the digital-game-based learning group achieved much more than their counterparts in paper-and-pencil learning.

The study of Ku et al (2014) revealed that digital games were found to enhance confidence and performance in mathematics because they are goal specific, they give immediate feedback and provide various levels of challenge. Ku et al (2014) argue that specific goals function of digital games gives students a chance to obtain a sense of success. Immediate feedback plays the role of support and allows students to seize their own progress and move forward towards achieving their goals (Bello, 2014). The different levels of challenge allow learners of different levels of ability to enter the flow state (Ku et al, 2014). The results of this study may only apply to western countries owing to differences in the socio-cultural and economic backgrounds that exist between USA and Kenya. Furthermore, this study did not consider the influence of teachers’ ICT knowledge and skills on use of ICT in teaching mathematics. The current study addressed this concern by focusing on how teachers’ professional development influenced their use of ICT in teaching mathematics.

Mwangi (2014) conducted a study to establish availability and access of computers to teachers and pupils in secondary schools in Nairobi and Kiambu counties, Kenya. The study employed descriptive survey design in which 278 teachers and 375 students participated in the study. The study found that there was insignificant use of computers and the internet in the teaching and learning process. The study also found that in most
schools, computers were mainly used for teaching computer literacy skills rather than using them for teaching and learning purposes. Furthermore, the study found that computers were mainly used for administrative work in the schools particularly in record keeping. Only 28% of the teachers were found to be using computers for learning purposes. Mwangi (2014) attributed this state of affairs to teachers’ lack of requisite competencies necessary for integration of ICT into their pedagogical activities. This study collected quantitative data on the use of ICT in teaching through the use descriptive survey. The current study however collected both qualitative and quantitative data by use of mixed method design. This design provided more comprehensive data on the use of ICT in teaching of mathematics (Mcmillan and Schumacher, 2010). In addition, mixed methods approach offered the researcher opportunities to use the strengths of both methods to counterbalance the weaknesses of each other thereby increasing the credibility of the findings for the study.

2.5 Teacher Training and Use of ICT in Teaching Mathematics

According to Puckett, and Cabuk (2004) teachers’ acquaintance, confidence, and competency in selecting appropriate learning software and eventually using ICT in the classroom instruction largely depends on teacher training and professional development. Owing to the fact that the use ICT in classroom instruction is relatively new, many teachers are yet to receive adequate training on ICT integration in their pedagogical practices. Mingaine (2013) argues that professional development of teachers is key to any successful implementation of technology integration in the any educational program. Cubukcuoglu (2013) investigated factors enabling use of ICT in Northern Cyprus secondary schools. The target population included seven volunteer teachers in one of the
public secondary school. Data was collected through teacher interviews. The participating teachers indicated that there was lack of adequate training among teachers in their pedagogical use of ICT in the classroom. The teachers interviewed reported that adequate training of teachers was an important enabler in the use of ICT in classroom instruction. The teachers viewed sufficient training as a necessity in the effective use ICT in teaching. The teachers interviewed suggested that the training of teachers should not just involve improvement of ICT skills but should also provide adequate opportunities for teachers to learn pedagogical ways of integrating ICT in the classroom. The sample of only seven Cypriot teachers used for the study might not have been adequate in generalizing the study results to the Kenyan situation. The current study therefore employed a much bigger sample of teachers teaching in the lower primary schools.

Rastogi and Malhotra (2013) conducted a study in India to examine teachers’ attitude towards ICT; level of their competence in ICT skills; their experiences with ICT; and how best they use ICT in their pedagogical practices. Purposive sampling technique was employed to select 20 schools endowed with computers and internet facilities. In each of the schools, 5 teachers teaching 9th grade were sampled. Questionnaire, interview and observation techniques were employed to collect both qualitative and quantitative data on teachers’ attitudes, competencies in ICT and pedagogical practices. The study found that successful integration of ICT in classroom practice depended largely on teachers’ level of competence in ICT knowledge and skills. It also found a strong positive relationship between possession of ICT knowledge and skills and teachers’ actual integration of ICT in the classroom instruction. Sadik (2008) argues that the use of technology for learning
purposes could only bear fruit if teachers possessed the requisite competencies necessary to enable them use technology appropriately in the classroom. However, the findings of this study could not apply to the Kenyan context owing to the socio-cultural differences between Kenya and India. Furthermore, this study did not focus on use of ICT in teaching and learning mathematics but generally focused on the use of ICT in the 9th grade across the curriculum. The current study therefore mainly focused on use of ICT in the development of mathematics concepts in lower primary schools.

Inan and Lowther (2010) conducted a study in USA to examine the effects of teachers’ characteristics and factors that influence their use of ICT in the classroom instruction. The study found that teachers’ computer proficiency had a significant influence on their beliefs about use of ICT in classroom practice. It further found that teachers’ beliefs had a strong influence on integration of ICT in their pedagogical practices. One possible limitation of this study was, although it included computer proficiency within the explanatory variables of teachers’ use of ICT in classroom practice, it did not consider ICT integration skills as a variable in its definition ICT proficiency. The current study did not only consider teachers’ basic ICT skills but also looked into teachers’ pedagogical integration of ICT into teaching of mathematics as a construct defined in this study as technological pedagogical and content knowledge.

Kagocha (2013) conducted a study in Nyeri County on teachers’ ICT competencies, access to ICTs and their use in classroom instruction. The study found that most teachers only possessed basic computer literacy skills mainly acquired through personal
initiatives. Majority of the teachers did not possess knowledge and skills required to effectively integrate ICT in their pedagogical practices. Pelgrum (2001) argues that the success of any educational program depends largely on knowledge and skills that the teachers (program implementers) possess. The study also found that despite availability and access of desktop computers and internet, teachers did not adequately use them in their teaching. The study attributed this state of affairs to lack of requisite ICT knowledge and skills amongst the teachers and also lack of technical support in the use of ICT. Furthermore, the study found strong correlation between teachers’ ICT competencies and their actual use of ICTs in the classroom. However, the study did not focus on ICT use in mathematics but general integration of ICT into the learning process. Furthermore, the study used descriptive survey to collect data. The current study employed mixed methods approach to collect both qualitative and quantitative data on use of ICT in development of mathematics concepts in lower primary schools.

Tondeur, Krug, Bill, Smulders and Zhu (2015) conducted a study in Kenyan secondary schools to explore integration of ICT in the delivery of curriculum content. The study was carried out in four secondary schools without previous access to ICT facilities. The study employed mixed methods approach to collect data from teachers, school leaders and ICT co-ordinators. The study focused on the use of ICT in teaching with emphasis on vision building, leadership, collaboration, teachers’ expertise in ICT use and adequacy of ICT resources. The study found that ICT was poorly used by the pupils. It also found that none of the teachers was able to use ICT for pedagogy before the start of a teacher Professional Development (PD) programme. A teacher PD was embedded in the study. The study further found that the teachers only started using ICT in their pedagogical
classroom practices at the end of a two-year teacher PD programme. The field notes and results from the focus group discussions indicated that the use of ICT in teaching and learning steadily increased after the PD programme (Tondeur et al, 2015). The findings of the study however indicated that the increased use of ICT devices was only limited to the preparation of lesson plans. The results of this study identified teachers’ lack of expertise in the use of ICT in teaching as one of the major challenges hindering effective integration of ICT in the classroom practice.

In a nutshell, the study found that the objective of integrating ICT across secondary school curriculum had not been so far realized (Tondeur, 2015). In the light of the study findings, Tondeur and his colleagues suggested that there was need to develop a robust teacher professional development programmes that supports teachers’ learning of appropriate use of ICT in their teaching. Moreover, the researchers suggested that teachers should be given opportunities to share their successes and failures, challenges and new discoveries (Tondeur et al, 2015). This study only focused on the training needs of secondary school teachers. Training needs of teachers teaching in the lower primary schools were not given much attention. The current study therefore gave more attention on the training needs of teachers in the use of ICT in teaching mathematics in lower primary schools.

2.6 Support to Teachers in the Use of ICT in Teaching

Inan and Lowther (2010) in their study found that teachers’ overall support particularly technical support had a significant influence on teachers’ beliefs about the importance of
ICT in teaching. Teachers’ beliefs in turn had a strong influence on teachers’ subsequent use of ICT in teaching.

Buabeng-Andoh (2012) reviewed literature on factors influencing teachers’ adoption and use of ICT in teaching. He found that teachers’ adoption and integration of ICT in teaching was influenced by school characteristics, teacher professional development and technical and leadership support among many other factors. He argues that school factors help teachers to improve their attitudes in the use of ICT in the classroom. According to Cubukcuoglu (2013) school factors influence accessibility and use of ICT facilities. Furthermore, Buabeng-Andoh (2012) argued that teachers require technical support in their use of ICT in delivery of school curriculum. Jones (2004) reported that lack of technical support to teachers in using ICT leads to breakdown of ICT tools consequently resulting in learning interruptions. BECTA (2004) indicated that there was a general lack of technical support in British schools which resulted in frustrations and apathy among teachers. Tong and Trinidad (2005) argued that lack of technical support makes teachers to become frustrated resulting in their unwillingness to use ICT in teaching. Buabeng-Andoh (2012) also found that leadership support was a necessity in the integration of ICT in teaching and learning. Similarly, Anderson and Dexter (2005) found that school leadership was a strong predictor of ICT use in teaching.

Kiunga (2014) found that the level of use of technology by physics teachers in Tigania Sub-County was very low. This was attributed to teacher’s lack of adequate ICT skills to embrace technology integration in the teaching of physics. This study further revealed that although teachers and students had adequate access to computers, Physics teachers
generally lacked basic computer skills. Therefore, majority of them did not use available computers in their teaching of physics. In another study, Wanjira (2010) found that despite the fact that teachers in Narok and Bomet counties had access to computers, they did not use them for teaching purposes. Therefore, availability and access to computers did not translate into their use in teaching. According to Tondeur et al (2015) teachers alone cannot manage the challenge of effectively integrating ICT in the teaching-learning process. Integration of ICT in the classroom practice calls for good school leadership, technical support and collaboration with other professionals. Stoll (1999) strongly advocated for development of a shared school vision on ICT use in teaching and learning based on unique needs of each school. Tondeur et al (2015) emphasized the importance of supporting teachers in the course of improving their expertise in teaching with ICT. Tondeur and colleagues further argued that this kind of support should go beyond the mere organization of training sessions for teachers to improve their technical competencies. Likewise, Krug and Arntzen (2010) argued that the pedagogical challenge of using ICT in teaching calls for teachers not only to acquire ICT skills but also to understand most importantly the methods of teaching using ICT to enhance learning. Information on the kind of support teachers teaching in the lower primary schools in Kenya get in their use of ICT was scarce. The current study sought to establish the kind of support teachers teaching lower primary schools in Mombasa get in their use of ICT in teaching mathematics.

2.7 Influence of Using ICT on Teachers’ Pedagogical Practices

Drijvers, Doorman, Boon, Reed and Gravemeijer (2010) conducted a study in the Netherlands to investigate types of orchestrations teachers developed when using ICT in
the teaching of mathematics. Data consisted of 38 video-recorded mathematics lessons conducted by three teachers. Data also included the views of these three teachers that were collected through questionnaires and interviews. Consequently, data was analyzed using qualitative analysis techniques to identify the orchestration techniques teachers employed in their use of ICT in teaching mathematics.

Six orchestration types were identified through a combination of theory-driven and data-driven analysis techniques. The six orchestration types included the following: The first type was technical-demo orchestration technique which involves the teacher projecting an ICT digital screen during the mathematics lesson and it allowed learners to follow his/her demonstrations. Second type identified in this study was the explain-the-screen orchestration technique. This orchestration technique involves the teacher explaining to the whole class what was happening on the ICT screen that was projected to the whole class to observe.

The third type was link-the-screen orchestration technique which involves the teacher stressing the relationship that exist between information projected on the ICT screen and how this could be represented in a conventional learning environment of using textbooks and chalkboard. In this technique, both the chalkboard and computer screen are made visible to learners during the mathematics lesson. The fourth type was discuss-the-screen orchestration technique that involves the whole class discussing mathematics problems projected on the digital screen. Drijvers et al (2010) argues that the discussions that are held in an ICT environment are more rewarding than those done in a conventional chalkboard-textbook environment. This could be attributed to the fact that in an ICT
environment, suggestions for different representations and techniques as they emerge in
the discussion could easily be tried out with expeditious feedback. The chalkboard and
textbook learning environments may not provide this kind of feedback to the learners.
The fifth type was spot-and-show orchestration technique. This technique involves
effective use of students’ reasoning in enhancing teaching and learning of mathematics
by identifying and deliberately using students’ work during mathematics classroom
discussion. Finally, the sixth type was a unique technique referred to as the Sherpa-at-
work orchestration technique. This technique involves a student generally referred to as
Sherpa being allowed to use a computer to carry out the teacher’s instructions in solving
a mathematics problem. In this technique, the classroom settings are organized in such a
way that a student is in control of using ICT devices while all the other students follow
that particular student and the teacher easily. Sherpa could be any of the learners in the
mathematics class.

This study found technical-demo orchestration as the most commonly used technique in
teaching mathematics. In the post-intervention interviews after the lessons, the three
teachers unanimously agreed that technical-demo technique was useful because it helped
children familiarize themselves with basic ICT techniques. The results of the study also
found that spot-and-show and link-the-screen orchestration techniques were frequently
used by the teachers in teaching mathematics. Sherpa-at-work orchestration technique
was however found to be the least used in teaching mathematics. Owing to the socio-
cultural difference between Netherlands and Kenya, the findings of this study could not
be generalized to the Kenyan context. Furthermore, the sample size of three teachers that
was used for study was too small to entertain that kind of generalization. The current study thus was carried out in Mombasa using a much bigger sample of teachers to examine orchestration techniques that they employed in their use of ICT in teaching mathematics.

Chrysanthou (2008) conducted a case study in Cyprus to explore the potential of Geogebra Mathematics Learning Software in teaching mathematics to 6th grade students. Geogebra is a form of freely-available, open-source educational mathematics software that provides tools for visualizing mathematics ideas (Chrysanthou, 2008). The software is used to teach mathematics by linking geometry and algebra in a single easy to use package. This software is easily available on the internet and covers content from elementary to university level (Chrysanthou, 2008). The study targeted one teacher with her 16 children in the 6th grade. Data was gathered through observation of lessons that were video-recorded, teacher interviews and student questionnaire. Data was qualitatively analyzed using socio-constructivist theoretical lens. Consequently, three broad themes emerged from the analysis namely: Classroom organization and management, cognitive amplification and student attitudes.

Under the broad theme classroom organization and management, the study found that the Geogebra Software brought about changes in the classroom environment that was a departure from normal routine. The use of ICT in teaching mathematics was viewed by teachers and students alike as a break from normal classroom routine. This consequently contributed in making mathematics lessons more interesting and enjoyable to the learners.
(Chrysanthou, 2008). The software was also found to enhance productivity in classroom activities. The participants reported that the software assisted them in saving time while at the same time boosting the number of examples given in a single mathematics lesson. Finally on this theme, the study found that the software was able to transform the relationship between teachers and learners in the classroom. Geogebra Software was found to assign the teacher the role of source of information in which students sought clarification and guidance from the teacher although the programme utilized the learner-centred approach. The students explored mathematics concepts in groups as the teacher provided advise and support in the background.

The second broad theme that emerged from data analysis was cognitive amplification (Chrysanthou, 2008). Geogebra Software was found to buttress and enhance learning of mathematics concepts. Pea (1985) argues that Geogebra provides powerful cognitive tools that improve learners’ ability to construct knowledge thereby opening up new possibilities of thought and action. The study found that the software was able to help students to improve in their areas of weakness, correct mistakes, generate accurate results, conceive novel ideas and enhance attention and concentration (Chrysanthou, 2008). Furthermore, it was found that the software increased opportunities for low achieving students to actively participate in mathematics lessons. In addition, the software helped learners to adduce mathematics features by generating visual representation of mathematical figures learnt. The students were able to enlarge or shrink shapes in order to reflect on the mathematical relationships, discover patterns, thus constructing mathematical knowledge.
Finally, on the third broad theme of student attitude, the software enabled the students to engage in activities that investigated, interacted, discovered and co-operated with peers in learning mathematics (Chrysanthou, 2008). According to Chrysanthou the students characterized the mathematics lessons as fun, easy, exciting and pleasurable. The software was found to be endowed with capacity in making mathematics learning easy, attractive and enjoyable. It also increased student engagement and autonomy in their learning of mathematics. Papert (1994) asserted that the best practice in learning takes place when learners take charge of their own learning. Agalianos, Noss and Whitty (2001) posited that when students work on a computer they develop more control of what they do than those solely rely on the teacher as the only source of knowledge. This is because a computer gives students opportunities to try out things. The findings of this study might not have applied to the Kenyan context because of the socio-cultural differences that exist between Cyprus and Kenya. Furthermore, the sample size of only one teacher and 16 pupils could not have been sufficient in generalizing the findings to the use of ICT in teaching mathematics by other teachers.

2.8 Determinants of Use and Non-use of ICT in Teaching Mathematics

The following factors have been found to hinder the use of ICT in classroom instruction: Lack of teaching experience with ICT tools; lack of technical support in the use of ICT for instructional purposes; lack of a help in managing children during ICT use; lack of ICT specialist teachers to impart ICT skills in children; and inadequate ICT resources, finances and time to successfully integrate ICT into teaching (Mumtaz, 2000). According to Mumtaz (2000) the following factors encourage teachers to use ICT in their teaching: Teachers’ motivation and commitment to students’ learning; teachers’ commitment to
professional development; administrative support in the use of ICT in teaching and learning as well as adequate access of ICT tools to both the teachers and learners alike.

Cubukcuoglu (2013) conducted a study in Northern Cyprus to investigate factors enabling use of ICT in teaching. The study targeted seven secondary teacher volunteers from a school that was conveniently located near the researcher. The school selected for the study was a public maintained institution provided with adequate ICT facilities for learning purposes. The results of the study were coded into three categories as: school factors, teacher factors and additional enablers of technology. Lack of access to the computer room emerged as a strong factor hindering the use of ICT in teaching (Cubukcuoglu, 2013). The teachers who participated in this study reported that the school had only one computer room that was usually used for teaching basic ICT skills. Therefore accessibility to the computer room for the purposes of curriculum delivery was rather difficult. Moreover, the study found that no time schedule was put in place to facilitate proper use of the computer room. According to Forgasz (2006) availability of computer rooms offer ample opportunities for effective use of ICT tools in teaching and learning. The teachers who participated in the study pointed out that had they been given ample opportunities to regularly access the computer room through an organized booking system, they would have explicitly used ICT tools in their teaching (Cubukcuoglu, 2013).

The other school factors that emerged from this study as enablers of ICT use in teaching were; availability and access to adequate ICT devices, adequate opportunities for teacher training and the school principal’s attitude towards use of ICT in teaching. Teachers’ beliefs in the benefits of using ICT in teaching and learning process emerged as the most
important teacher factor enabling use of ICT in the classroom. Cox, Preston, and Cox (1999) argue that it is important for teachers to be conscious about the benefits of using ICT in the classroom. This is because it helps the teachers not just to use ICT for the sake of it but to use it for the benefit of learners. The findings of this study could not be generalized to the Kenyan context because the sample of one public secondary school selected from Northern Cyprus could have been adequate. The current study employed a much bigger sample consisting of teachers teaching in lower primary schools in Mombasa, Kenya.

Tondeur et al (2015) investigated the determinants of ICT use in the teaching across secondary school curricular in Kenya. The study explored the use of ICT in classroom practice with focus on school vision in the use of ICT, school leadership, collaboration, teachers’ expertise and access to adequate ICT resources. The study found that the use of ICT in teaching and learning was insignificant. These state of affairs were attributed to lack of proper vision on the type and use of technology in the schools, lack of access to electricity in the classrooms and frequent power breakdown in cases where there was electricity. The study also found that access to appropriate and supportive infrastructure in the use of ICT was generally lacking in the schools. This study identified a range of challenges in the use of ICT in teaching. These included teachers’ limited ICT expertise to facilitate child-centred ICT use in learning, lack of time and large number of pupils per class.

According to Tondeur and colleagues, teachers alone cannot manage the challenge of effectively integrating ICT into the teaching-learning process (Tondeur et al, 2015). They
argued that effective integration of ICT into classroom instruction calls for good school leadership and support and collaboration with other professionals. In this regard therefore, Stoll (1999) emphasized the importance of developing a shared school vision based on unique needs of each and every school. The results of this study shed more light on factors that encourage or hinder successful integration ICT into the teaching-learning process. This study however mainly focused on secondary schools that had no previous access to ICT resources. The results of this study therefore could not apply to use of ICT in lower primary schools with previous access ICT devices. The current study thus examined factors that encouraged or hindered the use of ICT in teaching mathematics in lower primary schools already with ICT tools meant for learning purposes.

2.9 Summary of Literature Reviewed

Literature reviewed revealed that there was widespread use of ICT in the teaching of mathematics in USA and European countries. Studies conducted on the use of ICT in teaching and learning of mathematics in the Kenyan context are limited. Furthermore, studies conducted on the use of ICT in teaching and learning of mathematics have mainly focused on secondary schools. There has been little focus on use of ICT on development of basic mathematics concepts in the lower primary schools. Literature reviewed further indicated that availability and access to ICT resources did not automatically translate into integration ICT in teaching and learning of mathematics. Teachers’ ICT competencies and technical support towards use of ICT were found to be among the major factors encouraging or hindering teachers’ use of ICT in their teaching. There is limited focus on strategies used in integrating ICT tools in supporting teaching and learning particularly of basic mathematics concepts. Literature reviewed also revealed that most studies have
mainly used experimental and survey methods to collect quantitative data on the use ICT in teaching and learning. However, limited studies have employed mixed methods approach to collect comprehensive data that gives deep insight on how ICT tools are used to enhance learning in the classroom. The current study therefore employed mixed methods approach in gathering comprehensive qualitative and quantitative data on the level and manner of use of ICT tools in the teaching of mathematics concepts in the lower primary schools.
CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter focuses on description of research design and locale, target population, sampling techniques and sample size determination. The chapter further describes research instruments, pilot study, validity, reliability and data collection and analysis procedures employed for the study.

3.2 Research Design and Locale

This section describes the research design and data collection techniques employed for the study. It also describes the location where the study was conducted.

3.2.1 Research Design

Mixed methods research design which involved a combination of quantitative and qualitative data collection and analysis techniques was adopted for this study. Hudson (2012) assert that mixed methods research design involves the integration of quantitative and qualitative approaches within a single study. According to Johnson and Christensen (2010) mixed method design involves a combination of techniques of collection, analysis and interpretation of both quantitative and qualitative data at different stages of a research study. In this study, both quantitative and qualitative methods were incorporated in such a way that the researcher adopted a questionnaire technique (structured survey) for gathering quantitative data while semi-structured interview and observation techniques were used to gather qualitative data on teachers use of ICT in teaching mathematics. In a
social science research such as the current study, no single data collection technique is ideal (Chrysanthou, 2008). This is because each technique has potential strengths and weaknesses. Therefore the researcher used mixed methods research approach to enable him to use the strengths of both methods in offsetting the weaknesses of each other.

The study adopted mixed methods design because by using both quantitative and qualitative techniques sequentially to examine teachers’ use of ICT in teaching numeracy concepts, it offered more confidence in the validity and reliability of the findings. It also minimized errors that might have occurred as a result of employing a single method approach. The current study particularly employed Explanatory Sequential Mixed method design in which data was collected in two phases. Quantitative data was collected in the first phase and qualitative data was then collected in the second phase in order to gather more information useful in explaining the quantitative data. The qualitative data collected in the second phase of this study mainly focused on the initial findings and explored them in more depth. Figure 3.1 depicts the sequence of events during data collection and analysis.
This study was also a cross-sectional research in design and nature. According to Bryman (2008) cross-sectional study entails collection of data on more than one case at a single point in time in order to develop a body of qualitative or quantitative data in relation to two or more variables under study to establish patterns of association or variation. Figure 3.2 depicts a diagram showing steps for a cross-sectional research design that were followed in this study.
3.2.2 Locale of Study

The study was carried out in Mombasa County, Kenya. Mombasa County was selected for the current study because many public primary schools had acquired ICT devices for instructional purposes. According to Uwezo Report (2012) approximately 50% of schools...
in Mombasa County had computers for instructional purposes. Furthermore, the quality of education at the Coast where Mombasa County is situated is particularly wanting due to high teacher to pupil ratio (TPR). The Government of Kenya (2006) envisioned that integration of ICT in education would go a long way in addressing the challenge of high teacher-pupil ratios consequently improving the quality of education in public primary schools. There was therefore need to address the issue of quality of education in Mombasa through use of ICT in the teaching-learning process. One way of doing this was by examining how teachers’ used ICT tools in enhancing learning of numeracy concepts as well as factors encouraging or hindering their subsequent use.

3.3 Target Population

The study targeted all the public and private lower primary schools in Mombasa County. There were approximately 88 public and 348 private primary schools. It also targeted all the teachers teaching in the lower primary schools in the county.

3.4.0 Sampling Techniques and Sample Size

This section describes the techniques used to select the sample for the study. It also describes how the sample size was determined.

3.4.1 Sampling Techniques

Purposive sampling technique was employed to select both public and private primary schools with ICTs for instructional purposes. Seventeen (17) public and twenty-three (23) private primary schools in Mombasa County with ICT facilities were purposively selected for the study. Purposive sampling procedures ensure that only typical and useful
cases are selected for a study, in this case schools with ICTs. A purposive sample is selected in a deliberate and non-random fashion to achieve a certain goal or purpose (Cohen and Manion, 1998). Further, Johnson and Christensen (2004) state that a purposive sample aims at selecting information and seeking data-rich cases for in-depth study to investigate meaning, interpretations, processes and theory. Three teachers teaching in the lower primary (one from each of the grades 1, 2 and 3) were purposely sampled from each of the schools to participate in the survey. In the event that a school had more than one teacher in each of the three lower grades, then only one teacher was selected from each using simple random sampling procedures. Furthermore, simple random sampling technique was employed to select seven (7) teachers from the nineteen (19) who had indicated that they used ICTs in teaching mathematics. The seven teachers were further subjected to post-questionnaire mathematics lesson observations and interview to gather qualitative data.

3.4.2 Sample Size Determination
A sample 120 teachers teaching in grades 1, 2 and 3 was selected from each of the 40 primary schools from Mombasa County for this study. The schools were sampled on the basis of having ICT facilities for instructional purposes. Kline (2005) recommends a sample size of 100 – 150 cases to ensure a fair level of multivariate normality. The sample size for the current study satisfied this guideline and therefore it was deemed be adequate. Table 3.1 shows the sample size for the study.
Table 3.1: Sampling Frame for the Study

<table>
<thead>
<tr>
<th>School Type</th>
<th>Mvita Sub-County</th>
<th>Kisauni Sub-County</th>
<th>Changamwe Sub-County</th>
<th>Likoni Sub-County</th>
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<td>10</td>
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</table>

3.5.0 Research Instruments

Three instruments were employed to collect data for the study. They included the Teacher Questionnaire (TQ), Observation Protocol (OP) and Teachers’ Interview Protocol (TIP). These instruments were constructed considering widely accepted core indicators of measuring technology in education (UNESCO Institute of Statistics [UIS], 2009). The rationale for using global core indicators for measuring technologies in education is useful in formulating a framework for collecting cross-nationally comparable data on technology use in education (Partnership on Measuring ICT for Development, 2010). The three instruments are discussed below:

3.5.1 Teacher Questionnaire (TQ)

Teacher questionnaire was used to collect data from the teachers. This method was selected based on the understanding that the population under consideration was literate, large and information solicited from them could easily be described in writing. The TQ was a five-part closed-ended questionnaire that was used to collect quantitative data on teachers’ use of ICTs in teaching numeracy concepts in the lower primary schools. Teachers took approximately 30 minutes to complete filling the questionnaire. Part A of the questionnaire had questions capturing teachers’ demographic information. The
information captured in this section included data on teachers age, gender, level of education attained, teaching experience, experience with ICT devices and training in ICT use. Items in this section of the questionnaire included both open-ended and closed-ended questions. The teachers responded on an item on competence in teaching numeracy concepts by using a four-point likert scale ranging from excellent, very good, good to weak.

Part B of the TQ captured data on teachers’ access to ICT devices in teaching mathematics. The teachers responded to each ICT device indicated by ticking one of the following responses: not available, available in the computer laboratory, available in the classroom and available in the office. In Part C of the TQ, teachers responded to nine statements capturing data on their actual use of ICT resources in teaching mathematics concepts. The teachers were required to tick in one box for each item with the following responses: never, once per term, once per month, once per week, a few times a week and finally, daily. In Part D, teachers responded to nine items of the TQ capturing data on their technological, pedagogical and content knowledge. They responded to items in this section by ticking one of the following likert scale alternatives: No competence, little competence, not sure, moderate competence and much competence. Part E of the TQ concerned gathering data on management and support given to the teachers by their schools in their use of ICT devices in teaching mathematics concepts in the lower primary. They responded to four items by ticking one of the alternatives given: Clearly no, mostly no, not sure, mostly yes and clearly yes.
Coding instructions for the Teacher Questionnaire were as follows: On teachers’ demographics the coding was; Male=1, Female=2. Age: Below 20years=1, 21-30years=2, 31-40years=3, Above 40years=4. Level of education: Certificate=1, Diploma=2, Degree=3, Masters=4. Teaching experience: Below 10years=1, 11-20years=2, 21-30years=3, 31-40years=4, Above 40years=5.

Access to computer and internet at home: Yes=1, No=2. Experience with ICT: Below 5years=1, 6-10years=2, 11-15years=3, Above 15years=4. Mathematics competence: Weak=1, Good=2, Very Good=3, Excellent=4. ICT training: Yes=1, NO=2. Place of ICT training: Self initiative=1, Seminars/Workshops=2, Commercial College=3, Teacher Training College/University=4. Availability of ICT resources: Not Available=1, Office=2, Computer Lab=3, Classroom=4. Use of ICT in teaching mathematics: Never=1, Once per term=2, Once per month=3, Once per week=4, A few times a week=5, Daily=6. TPACK knowledge: No competence=1, Little competence=2, Not sure=3, Moderate competence=4, Much competence=5. Management and support: Clearly No=1, Most No=2, Not Sure=3, Mostly Yes=4, and Clearly Yes=5. Appendix I is the sample of the Teacher Questionnaire instrument for this study.

3.5.2 Observation Protocol (OP)

The researcher employed observation technique to collect qualitative data on use of ICT in teaching mathematics from teachers who had indicated in their questionnaires that they employed ICT in teaching. Seven mathematics lesson episodes involving seven lower primary school teachers in seven schools were observed and video-recorded. The lessons
were video-recorded in order to free the researcher from the need to take detailed notes. Observation is a powerful tool that affords the opportunity to gather live data from social contexts as they emerge (Simpson, 2003).

According to Simpson (2003) observation technique also enables the researcher to get inside situations and observe directly what is actually happening on the ground; thus gathering more accurate and credible data (Cohen, Manion & Morrison, 2007). In addition, Simpson (2003) asserts that observation is a robust research technique for gathering data. It gives direct access to social interactions as well as being able to enrich data collected by use of other techniques. The OP was also very helpful in bridging the gap between what teachers said and what they actually did. The researcher assumed the role of a participant observer. Participant observation gives the researcher the chance to study behaviors and at the same time be friendly with participants so they do not treat him as an intruder (Simpson, 2003).

3.5.3 Teachers Interview Protocol (TIP)

Teachers who had indicated in the Teacher Questionnaire that they used ICT devices in teaching mathematics were further subjected to an interview immediately after lesson observation. Cannell and Kahn (1968) define interview as a conversation between two or more people with the purpose of gathering data relevant to research on content determined by research objectives. TIP was a semi-structured interview procedure that comprised of eight items. This tool helped in generating qualitative data on teachers’ use of ICT in teaching mathematics concepts. The tool was also used to triangulate data
generated through the Teacher Questionnaire. Appendix II is the sample of the Teachers Interview Protocol instrument for this study.

3.5.4 Pilot Study

To determine the suitability of the research instruments for the current study, a pilot study was conducted. Two schools were purposively selected for the pilot study on the basis of having ICT devices for learning purposes. One of the schools was public and the other one was private. A sample of 6 teachers teaching in the lower primary section were randomly selected, 3 from each of the schools selected. According to Robinson (2002) a pilot study is a small-scale version of the real study to check the feasibility of the proposed research. The pilot study helped to check the language used in the research instruments to ensure that it was clear enough and appropriate. The pilot study also helped to identify vague and ambiguous items for necessary adjustments before the actual study was carried out. Yin (2003) asserts that a pilot study helps the researcher to improve data collection plans in terms of data content and procedures. As a result of the pilot study conducted, a number of adjustments were made to the research instruments as well as the entire research design. The two schools that were selected for the pilot study were not included in the actual study to avoid the effect of pre-instrument sensitization.

3.5.5 Validity

Experts were used to check the validity of the Teacher Questionnaire and the Teacher Interview Protocol. The researcher with the help of lecturers from the Department of Early childhood Studies of and experts from ICT Authority checked for content validity by going through each item of the questionnaire to establish whether they were
generating the required data according to the research objectives. The items that were found not adequate in generating the required information were dropped and other more appropriate items were suggested that were able to generate useful data to address the research questions. McMillan and Schumacher (2010) suggest that it is necessary to have experts examine the instrument items in order to judge their representativeness. Further, respondent validity was established by going through the answers given by respondents during the pilot study to ascertain accuracy and credibility of the information given. Items that generated ambiguous and vague responses were revised accordingly.

The validity of the results was also established through triangulation technique. According to Onwuegbuzie, Jiao and Bostick (2004) triangulation refers to the use of multiple approaches involving both qualitative and quantitative research techniques. The current study employed the use of mixed methods approach to collect and analyze data. Hudson (2012) argue that mixed methods approach to research ensures triangulation of the study outcome. Furthermore, Lincoln and Guba (1985) view triangulation as a mode of improving research outcome and making data interpretation credible. In this study, three forms of triangulation suggested by Denzin (1977) were performed: First, data triangulation which involved the use of a combination of data sources to check validity of the research process was performed. In this study, data was collected through teachers’ self reports using the Teacher Questionnaires. More data was then collected through voice-recorded interviews and video-recorded lesson observations. Second, theory triangulation was performed in which multiple perspectives were used to interpret the study findings. Third, methodological triangulation was performed in which both
qualitative and quantitative techniques were employed to gather and analyze data. Finally, the investigator triangulation was used during pilot study to validate the interview instruments. Investigator triangulation involves use of different investigators or observers.

3.5.6 Reliability

The reliability of the Teacher Questionnaire was established through test-retest procedures in order to check for its stability and consistency. The instrument was administered twice to the same group of teachers in a span of two weeks. The scores from the two administrations was correlated using Pearson’s Product Moment Correlation Coefficient. Internal consistency of the questionnaire was measured using Cronbach’s alpha. Cronbach’s alpha coefficient was computed using the SPSS program. Nunnally (1978) suggests that reliability coefficient of 0.7 or higher is a satisfactory level of an instrument’s reliability. He however recommends reliability coefficient of at least 0.9 in settings where important decisions are to be made with respect to specific tests. In the current study, the instruments were accepted as reliable if they attained a coefficient of 0.8 and above. According to Bowling (2009) reliability in research is synonymous to dependability, consistency, reproducibility or replicability over time, over instruments and over group of respondents.

The scores from the two administrations of the questionnaire were correlated using Pearson’s Product Moment Correlation Co-efficient. The instrument was found to be positively correlated at $r = 0.864$, using Pearson’s Moment Correlation technique as shown on table 3.2. Research instruments are normally accepted as reliable if they
correlate at $r = 0.8$ and above. Therefore the questionnaire used to collect data for the current study at $r = 0.864$ was accepted as reliable data collection instrument.

### Table 3.2: Pearson Correlation Coefficient for Test-Retest Results

<table>
<thead>
<tr>
<th></th>
<th>1&lt;sup&gt;ST&lt;/sup&gt; ADMIN.</th>
<th>2&lt;sup&gt;ND&lt;/sup&gt; ADMIN.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1&lt;sup&gt;ST&lt;/sup&gt; ADMIN.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>.864**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>6</td>
<td>.000</td>
</tr>
<tr>
<td><strong>2&lt;sup&gt;ND&lt;/sup&gt; ADMIN.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>.864**</td>
<td>1</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.05 level (2-tailed).

The internal consistency of the Teacher Questionnaire was further established using Cronbach’s Alpha coefficient reliability technique. Cronbach’s Alpha provides information about the relationship between individual items in a scale in order to determine how items correlate among themselves. Cronbach’s Alpha coefficient for the questionnaire computed after the pilot study is shown on tables 3.3 and 3.4 below.

### Table 3.3: Cronbach’s Alpha Reliability statistics

<table>
<thead>
<tr>
<th>Cronbach’s Alpha</th>
<th>No. of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>.890</td>
<td>5</td>
</tr>
</tbody>
</table>

In this study, the Cronbach’s Alpha was found to be .89 as indicated on table 3.3. Pallant (2005) indicates that an instrument with Alpha value of above .7 is considered reliable. Further, Cronbach’s Alpha for the four items of the Teacher Questionnaire were computed as shown on table 3.4. These figures give an indication of the degree to which
each item correlates with the total score. The Alpha for items measuring teacher demographics was .82, ICT availability was .86, ICT use in teaching mathematics was .75, items for technological pedagogical and content knowledge (TPACK) was .85 and items for ICT support was .89. Pallant (2005) argues that Cronbach’s Alpha values that a researcher should consider removing items whose alpha values are less than .7 from the scale. Such items are said to be measuring something different from what the scale as a whole is measuring.

<table>
<thead>
<tr>
<th>Item</th>
<th>Scale if Item Deleted</th>
<th>Scale Variance if Item Deleted</th>
<th>Correlated Item-Tot Correlation</th>
<th>Cronbach’s Alpha if Item Deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher demographics</td>
<td>14.77</td>
<td>28.671</td>
<td>.758</td>
<td>.821</td>
</tr>
<tr>
<td>ICT availability</td>
<td>15.69</td>
<td>30.667</td>
<td>.765</td>
<td>.863</td>
</tr>
<tr>
<td>ICT use in maths</td>
<td>13.81</td>
<td>26.657</td>
<td>.752</td>
<td>.747</td>
</tr>
<tr>
<td>TPACK knowledge</td>
<td>11.87</td>
<td>27.838</td>
<td>.784</td>
<td>.857</td>
</tr>
<tr>
<td>ICT support</td>
<td>14.66</td>
<td>29.424</td>
<td>.745</td>
<td>.893</td>
</tr>
</tbody>
</table>

The alpha values for items of the Teacher questionnaire used for the current study were considered reliable at an average of alpha value of .84. This figure is way above the minimum value of .7 required to declare an instrument reliable.

3.6.0 Data Collection

This section describes field procedures followed and logistical and ethical considerations adhered to during the study. The section also describes stages through data was subsequently gathered.
3.6.1 Research Protocol and Logistical Considerations

The researcher sought permission from relevant authorities to carry out the current study in the month of September, 2016. First, the researcher sought a research permit from the National Council of Science, Technology and Innovation (NACOSTI) to carry out the study after approval of the research proposal by the Graduate School of Kenyatta University (Appendix IV). Appendix V and Appendix VI are copies of Research Authorization and Research Permit respectively from NACOSTI. The researcher with the help of the permit from NACOSTI sought subsequent permission to conduct the study from the Mombasa County Commissioner as well as the County Director of Education. Subsequently, with the permit from NACOSTI, County Commissioner and County Director of Education, the researcher sought further permission from D.E.O’s offices in Kisauni, Mvita, Changamwe and Likoni sub-counties. Finally, the researcher met head teachers of various schools sampled for the study to brief them about the nature and activities of the study. The researcher then briefed the teachers about the nature of the study and information being sought in order to obtain informed consent for their participation in the study. The participants signed a consent form as a confirmation for their participation in the study. Appendix III is a copy of the research consent form used for the study.

3.6.2 Ethical Considerations

The study was conducted professionally and all ethical principles that govern research studies involving human beings were observed. First and foremost, the researcher obtained informed consent from the teachers who had been selected to participate in the current study. The participants were given adequate information how data would be
gathered and used. The researcher did not partake in any form of intrusion into classroom practice in the schools under study. The respondents’ were assured that their identities would be protected and that the information they shared treated with utmost confidentiality. Each participant’s privacy was respected as no participant was required to indicate their names on the instruments. Pseudo names were used in the analysis of the results to protect participants identity. The researcher also sought permission from parents and school authorities to observe mathematics lessons in the classrooms. No teacher was forced to participate in the study; they voluntarily took part in the current study. Additionally, all participants were given the option of choosing to withdraw from the study without adverse consequences. Finally, this thesis report has been complemented by referenced sources duly acknowledged. All text, data (including spoken words), graphics, pictures borrowed from other sources, including the internet, have been specifically accredited and references cited using current APA system and in accordance with anti-plagiarism regulations.

3.6.3 Actual Data collection
Data was collected during the month of October, 2016 in two phases as follows:

Phase one – This phase involved collection of quantitative data from the teachers using the Teacher Questionnaire. The researcher distributed questionnaires to the teachers teaching in the lower primary schools who then filled them in their respective institutions. This exercise was conducted during the afternoon sessions between 2.00 – 4.00 pm in order to minimize interference of normal learning sessions that was mostly done in the morning between 8 am and 12 noon in majority of the schools. The exercise
of filling questionnaires consumed approximately 30 minutes of the teachers’ valuable time.

**Phase two** – The second phase of the current study involved gathering qualitative data from classrooms and teachers using observation and interview procedures. This phase helped to generate qualitative data that focused on findings of phase one and explored them in more depth. This phase involved collecting data in two stages as follows:

1st **Stage** – In this stage, the researcher identified teachers who had indicated in their questionnaires that they used ICT devices in the teaching of numeracy concepts in lower primary. Nineteen (19) teachers from seven schools (three public and four private) indicated that they used ICT in teaching numeracy concepts. Six of the teachers hailed from public primary schools while thirteen hailed from private schools. The researcher then observed seven mathematics lessons involving seven teachers from seven schools (four private and three public). The lessons were conducted using ICT tools. Video episodes of mathematics learning sessions were captured using a digital camera. These video episodes are securely kept in confidence.

2nd **Stage** – In this stage, the researcher conducted an interview with each of the teachers immediately after lesson observation in order to explore further the data collected. The post-observation interview sessions were also electronically voice-recorded. The data collected was then organized and analyzed using both quantitative and qualitative techniques.
3.7 Data Analysis

Quantitative and qualitative techniques were utilized to analyze data for this study. The Statistical Package for Social Sciences (SPSS) software version ‘24’ was used to manage and perform statistical analysis of quantitative data. Significance levels between variables were tested at 0.05 using statistical techniques. Data was analyzed statistically using descriptive and inferential statistics. It was further descriptively analyzed using means, standard deviations, and percentages. The findings of the study were reported on the basis of objectives and hypotheses.

The Pearson Product-Moment Correlation Coefficient (r) technique was utilized to test hypothesis H02. Kothari (2004) states that Pearson’s Coefficient of Correlation is the most widely used technique of measuring the degree of relationship between two variables. Pearson’s r is used to measure strength of linear relationship between two continuous variables. One-way ANOVA (F-test) technique was utilized to test hypotheses H01 and H03. One-way ANOVA technique is suitable when comparing more than two independent groups of subjects exposed to different treatments (Oso & Onen, 2009). In this study, teachers were grouped on the basis of their access to ICT tools for teaching purposes and also support in their use of ICT in teaching numeracy concepts. One-way ANOVA was used to determine whether there were any statistically significant differences in means of different groups of teachers in using ICT in teaching numeracy concepts. The statistical hypotheses tested were as follows:

H01: There is no significant difference in the means of using ICT in teaching numeracy concepts between teachers who have access to ICT tools and those who do not have any access.
H₀₂: There is no significant relationship between teachers’ ICT training and their use of ICT tools in teaching numeracy concepts.

H₀₃: There is no significant difference in the means of using ICT in teaching numeracy concepts between teachers who receive support in use of ICT and those who do not receive any support.

MAXQDA software was utilized to organize, transcript and analyze qualitative data. Data was analyzed qualitatively to determine categories, relationships and assumptions that formed teachers’ views of using ICT in teaching numeracy concepts. The researcher utilized descriptive phenomenological technique to transcribe data into themes and sub-themes. The transcription of data from video-recorded observations and voice-recorded interviews was done according to a model proposed by Powell, Francisco and Maher (2003) which involves seven phases of data transcription. Although the model suggests seven sequential and non-linear phases, this study utilized the first five phases of the model as follows:

i. Viewing the video-recorded and listening to the voice-recorded data to familiarize self with the data

ii. Describing the video and voice data

iii. Identifying critical events that relate to the research questions

iv. Transcribing data to produce probable data transcripts

v. Coding the data to identify themes necessary to interpret the data

Creswell (2003) posits that qualitative data analysis begins with transcription of data. The researcher therefore generated codes from the transcribed data through open coding
system. Basit (2003) define data codes as tags or labels that are used to assign meaning to
descriptive information collected from a research process. The researcher further sorted
the codes earlier generated into categories using axial coding technique. These codes
were then used to generate core themes for the study. Basit (2003) further argues that data
coding plays an important role in the analysis of findings because it allocates meaning to
the descriptive or inferential information gathered. Basit further posit that creation of
codes and data categories helps to trigger the construction of conceptual schemes that suit
the data collected. The schemes in turn helps the researcher to pose questions, compare
information adjust or drop categories and arrange them in meaningful patterns. In the
analysis, the researcher also included verbatim interview episodes. Cohen et al (2007)
state that verbatim data helps to maintain the flavor of the original data that is
significantly rich in detail.
CHAPTER FOUR

PRESENTATION OF FINDINGS, INTERPRETATIONS AND DISCUSSIONS

4.1 Introduction

This chapter presents findings, interpretations and discussions of the study results according to objectives and hypotheses. Both quantitative and qualitative data was analyzed, interpreted and discussed in this chapter. The objectives of the study included:

a) To establish whether ICT devices were accessible to teachers for use in teaching mathematics in lower primary schools.

b) To establish whether teachers’ use of ICT tools empowers them to teach mathematics better.

c) To determine teachers’ training on ICT influences their use of ICT in teaching mathematics.

d) To determine the kind of ICT support teachers receive in their use of ICT in teaching mathematics.

e) To establish whether ICT tools influenced teachers’ pedagogical practices in teaching mathematics.

f) To examine factors that encourage or hinder teachers’ use of ICT in teaching mathematics.
4.2 General and Demographic Information

This section presents general and demographic information of participants as presented in sub-sections 4.2.1 and 4.2.2:

4.2.1 General Information

This study focused on public and private schools in relation to teachers’ use of ICT in teaching mathematics concepts. Data on the number of lower primary schools and teachers that participated in the study is presented on table 4.1:

Table 4.1: Research Participation Rate

<table>
<thead>
<tr>
<th>Description</th>
<th>Public</th>
<th>Private</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample</td>
<td>Participated</td>
<td>Sample</td>
</tr>
<tr>
<td>Schools</td>
<td>17</td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td>Teachers</td>
<td>51</td>
<td>47</td>
<td>69</td>
</tr>
</tbody>
</table>

Table 4.1 shows that out of the 40 schools sampled for the current study, 37 (93%) consented to participate in the study. It also indicates that 16 public and 21 private primary schools actually took part in the study. Three schools (one public and two private) declined to take part in the study citing inconveniences and busy school schedules as reasons for not participating in this study. Table 4.1 further shows that 47 teachers who participated in this study hailed from public primary schools while 62 were from private primary schools. Two teachers from the schools that participated in the study did not return their questionnaires. The teachers had granted
their consent to take part in the study, subsequently picked questionnaires but failed to return them. Nine teachers did not participate in the study at all because their head teachers had declined to grant consent for their schools to be involved in the study.

Therefore the number of questionnaires filled and returned was 109 representing 91% return rate. The study was therefore deemed successful because 91% of the teachers sampled granted their consent to participate in the study, completed filling their questionnaires and returned them.

4.2.2 Demographics on Teachers’ Characteristics

To gain insights into how teachers’ characteristics influenced their use of ICT in teaching mathematics, the researcher gathered demographic data on teachers’ gender, age, teaching experience, level of education, training on ICT skills, experience with ICT, places of ICT training and their ownership of ICT resources. According to Buabeng-Andoh (2012) teachers’ personal characteristics such as educational level, age, gender, educational experience and experience with ICTs has an influence on their adoption of ICT for classroom instruction. Buabeng-Andoh argues that an understanding of teachers’ personal characteristics that influence adoption and use of ICT in the classroom practice is relevant. Likewise, Inan and Lowther (2009) found that teachers’ demographic characteristics had both direct and indirect effect on their adoption and use of ICT in their classroom instruction.
4.2.2.1 Teachers’ Gender

The teachers’ gender was deemed important because previous studies have reported gender differences in the use of ICT in teaching. Data on teachers’ gender is presented on table 4.2.

<table>
<thead>
<tr>
<th>Category</th>
<th>Public</th>
<th>Private</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>0 (0%)</td>
<td>5 (8%)</td>
<td>5 (5%)</td>
</tr>
<tr>
<td>Female</td>
<td>47 (100%)</td>
<td>57 (92%)</td>
<td>104 (95%)</td>
</tr>
<tr>
<td>Total</td>
<td>47 (100%)</td>
<td>62 (100%)</td>
<td>109 (100%)</td>
</tr>
</tbody>
</table>

Table 4.2 indicates that all the teachers teaching in lower grades in the 47 public primary schools participated in the study were female. It further indicates that very few male teachers (8%) were teaching in lower grades in private primary schools. The study findings indicate that 95% of the teachers who participated in this study were female. This finding implies that most of the teachers teaching in lower primary schools in Mombasa county were female. This finding is inconsistent with those by Mogire (2013) and Mwangi (2014) who found that there were more male teachers teaching in secondary schools as compared to female teachers. Mogire (2013) found that 69% male and 31% female teachers in Kisii County were teaching in secondary schools. Likewise Mwangi (2014) found that there were 52% male and 48% female teachers in Nairobi and Kiambu counties. The differences in teachers by gender ratio between the studies mentioned above and the current study could have stemmed from the fact that majority of teachers who handle young children are female. Gender differences in the use of ICT in classroom
instruction have been reported in previous studies (Buabeng-Andoh, 2012; Kay, 2006; Markauskaite, 2006, Volman & Van Eck, 2001). Among these studies, female teachers have been reported to have low levels of ICT use, ICT access, skill and interest than their male colleagues (Volman & Van Eck, 2001). Similarly, Kay (2006) found that male teachers used ICT more in the classroom than their female counterparts. These findings imply that male teachers are more likely to integrate ICT in their teaching of mathematics than their female counterparts.

4.2.2.2 Teachers’ Age

Teachers’ age was deemed important because previous research has found age differences among individuals in their use of ICT. The researcher therefore gathered information on teachers’ age. Demographic data on teachers’ age is presented on table 4.3.

<table>
<thead>
<tr>
<th>Category</th>
<th>Private</th>
<th>Public</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 20 years</td>
<td>(0)0%</td>
<td>(0)0%</td>
<td>(0)0%</td>
</tr>
<tr>
<td>21 – 30 years</td>
<td>(22)20.2%</td>
<td>(14)13.2%</td>
<td>(36)33.4%</td>
</tr>
<tr>
<td>31 – 40 years</td>
<td>(16)14.6%</td>
<td>(27)24.5%</td>
<td>(43)39.1%</td>
</tr>
<tr>
<td>Above 40 years</td>
<td>(0)0%</td>
<td>(30)27.5%</td>
<td>(30)27.5%</td>
</tr>
<tr>
<td>n=109</td>
<td></td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

The study results as presented on table 4.3 indicates that generally, majority of teachers teaching in private primary schools were mostly young while those teaching in public primary schools were relatively older considering that quite a number of them were
above 40 years of age. None of the teachers in the private primary schools indicated any age above 40 years. This state of affairs could be attributed to the fact that teachers teaching in the public schools are employed by Teachers Service Commission (TSC) and therefore enjoy a security of tenure. Most of their counterparts in private schools may not enjoy that privilege. The study findings also revealed that in majority of the teachers, ages ranged between 21 to 40 years of age. The study found that nearly two thirds (72%) of the teachers were young as their ages ranged between 21-40 years, and only a third of the teachers (28%) ranged above 40 years. This finding is consistent with findings by Mogire (2013) and Mwangi (2014) which indicated that majority of teachers in secondary schools fall in the range of 25 to 45 years of age. They found that three thirds (75%) of teachers teaching in secondary schools in Kisii, Nairobi and Kiambu counties ranged between 25-45 years of age.

Van Braak, Tondeur and Valcke (2004) indicated that teachers’ age could indirectly influence their ICT use in classroom practice mediated by their computer attitude. Lau and Sim (2008) found that senior teachers (those with ages above 45 years) had vast teaching experience, good knowledge of subject matter and were able to digitalize learning content easily through the use of ICT. Likewise, Novak and Knowles (1991) argue that novice teachers normally experience difficulties in settling into their new roles as teachers and therefore were less likely to use ICT for teaching purposes. Therefore novice teachers are more likely to treat the use of ICT in teaching as a burden rather than an effective tool for enhancing teaching-learning process (Novak and Knowles, 1991). However, Lau and Sim (2008) reiterated that teachers aged below the age of 35 years were more likely to perceive themselves to be much more competent in the use of ICT.
than those aged above 35 years. Likewise, the National Centre for Education Statistics (2000) in their USA study found that younger teachers having grown up with ICT devices during computer era (digital natives) had greater ICT skills necessary to enhance their instructional processes. This observation was congruent with the International Telecommunication Union (2008) argument that individuals in the age range of 18 to 35 years are more responsive and attracted to ICT tools than individuals in any other age range. The findings of the current study revealed that majority of the teachers teaching in lower primary schools belonged to this age group.

According to Prensky (2001) people born and raised during the era of computers and digital technological advancement are referred to as digital natives while the older generation born before that era are digital immigrants. According to Prensky (2001) people born after the year 1981 are called digital natives and are very familiar with computer and internet use. This finding implies that majority of teachers teaching in lower primary schools in Mombasa are digital natives. These teachers are more likely to learn and use ICT tools effortlessly and with lots of fun.

4.2.2.3 Teachers’ Teaching Experience

The study also sought to establish teachers’ teaching experience. Teaching experience was envisaged as vital in this study because it was likely to influence teachers’ use of ICT in teaching mathematics. Data on teachers’ teaching experience is presented on table 4.4.
Table 4.4: Years of Teaching Experience

<table>
<thead>
<tr>
<th>Categories</th>
<th>Private</th>
<th>Public</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 years and below</td>
<td>(33)30.3%</td>
<td>(16)14.6%</td>
<td>(49)44.9%</td>
</tr>
<tr>
<td>11 – 20 years</td>
<td>(22)20.2%</td>
<td>(29)26.6%</td>
<td>(51)46.8%</td>
</tr>
<tr>
<td>21 – 30 years</td>
<td>(2)1.7%</td>
<td>(5)4.6%</td>
<td>(7)6.3%</td>
</tr>
<tr>
<td>Above 40 years</td>
<td>(0)0%</td>
<td>(2)2.0%</td>
<td>(2)2.0%</td>
</tr>
<tr>
<td>n=109</td>
<td></td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

The results of the study as shown on table 4.4 indicate that most teachers in public primary schools had many years of teaching experience as compared to their counterparts teaching in private schools. This state of affairs could be attributed to the fact that teachers teaching in public primary schools enjoyed a more security of tenure than their counterparts teaching in private primary schools. The study results also showed that majority of teachers in the county had an experience ranging between 11 and 20 years of teaching. Inan and Lowther (2009) found that teachers’ teaching experience influenced their ICT use in the classroom both directly and indirectly. Lau and Sim (2008) argue that senior teachers have wide teaching experience, good knowledge of subject matter and are able to digitalize learning content easily through the use of ICT tools. Likewise, Novak and Knowles (1991) claim that novice teachers experienced difficulties in settling into their new roles and therefore were much more likely to view the use of ICT in classroom instruction as a burden rather than an effective teaching-learning tool. However, Inan and Lowther (2009) found that novice teachers more readily integrated ICT in their classroom practice than the veteran teachers. They argued that new graduates were more knowledgeable and better prepared to use ICT than their more experienced peers. The
findings of the current study show that majority of the teachers in lower primary schools had teaching experience ranging from 11 to 20 years. This finding implies that most teachers teaching in lower primary schools in Mombasa County have wide experience with good mastery of subject matter and thus are likely to digitalize their mathematics teaching if appropriate ICT tools are availed.

4.2.2.4 Teachers’ Level of Education

Teachers’ level of education was considered as an important element in this study as it was likely to have a bearing on teachers’ use of ICT in teaching Mathematics. Data on the level of education of teachers is presented on table 4.5.

<table>
<thead>
<tr>
<th>Category</th>
<th>Private</th>
<th>Public</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certificate</td>
<td>(16)14.4%</td>
<td>(14)13.2%</td>
<td>(30)27.6%</td>
</tr>
<tr>
<td>Diploma</td>
<td>(18)16.5%</td>
<td>(22)20.2%</td>
<td>(40)36.7%</td>
</tr>
<tr>
<td>Bachelors degree</td>
<td>(14)13.2%</td>
<td>(22)20.2%</td>
<td>(36)33.4%</td>
</tr>
<tr>
<td>Masters degree</td>
<td>(0)0%</td>
<td>(3)2.3%</td>
<td>(3)2.3%</td>
</tr>
<tr>
<td><strong>n=109</strong></td>
<td></td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

The results of the study as shown on table 4.5 indicate that majority (72%) of the teachers in the county had qualifications above certificate level of training. The study results reveal that approximately a third (37%) of the teachers had diploma qualifications. It also found that nearly a third (33%) of the teachers had bachelor’s degree qualifications. Slightly more than a quarter (28%) had certificate qualifications. Only 2% of the teachers had post-graduate qualifications. The findings show all the teachers were dully trained.
and that none practiced as untrained teacher. These results imply that all the teachers in Mombasa County were adequately trained and were qualified to teach.

This finding is in agreement with Wanjira (2010) who found that all primary school teachers in Thika sub-county were trained and qualified to teach. The study found that 66% of the teachers had a Primary Teacher (P1) certificate and 34% had Diploma Teacher Certificate. None of the teachers had bachelors or post-graduate degree qualifications. Likewise, Mogire (2013) found that all the secondary school teachers in Kisii had been adequately trained; in that 28% had diplomas, 59% had a bachelor’s degree and 12% had a post-graduate degree. According to Mwangi (2014) and ITU (2008) teachers with higher tertiary qualifications are better users of ICT than their counterparts with lower qualifications. Mwangi (2014) argues that teachers who pursue post-graduate degree courses at the university have increased opportunities of using ICT tools in their studies thereby increasing their ICT skills which can be demonstrated in their pedagogical practices. The current study found that 2% of the teachers had post-graduate degree qualifications. These teachers were more likely to demonstrate a high degree of ICT integration into their teaching of mathematics.

4.2.2.5 Teachers’ Training on ICT

The study sought to establish teachers had been adequately trained in using ICT in teaching. This demographic was considered as an important element likely to influence teachers’ use of ICT in teaching Mathematics. Table 4.6 presents data on number of teachers trained and not trained in ICT skills.
The study findings as shown on table 4.6 reveal that majority of teachers in the county had undergone some formal training on ICT skills. Approximately 93% of the teachers indicated that they had trained on basic ICT skills. Only a paltry 7% indicated that they had not yet undergone any formal training on ICT skills. Peralta and Costa (2007) found that teachers’ technical competence in ICT influenced their use of ICT in teaching. This finding implies that most of teachers teaching in lower primary schools had basic ICT skills.

4.2.2.6 Places Where Teachers Received ICT Training

Further, the study sought to investigate institutions where teachers received their training on ICT. Data on places where teachers received ICT training is presented on table 4.7.

| Table 4.7: Places Where Teachers Received ICT Training |
| --- | --- | --- |
| Category | Frequency | Percentage |
| None | 9 | 8.3% |
| Seminars/Workshops | 43 | 39.4% |
| Commercial college | 28 | 25.6% |
| TTCs/Universities | 16 | 14.7% |
| TTCs/Seminars/Commercial colleges | 13 | 12.0% |
| n=109 | 100% |
The study findings as shown on table 4.7 reveal that majority (51%) of the teachers received their ICT training from workshops and seminars organized by the Ministry of Education and local NGOs in Mombasa. The findings show that more than a half of the teachers had attended ICT workshops, a quarter had trained through self-initiative in commercial computer colleges and finally an eighth had studied ICT skills in universities and teacher training colleges. Chao (2015) found that 42% of teachers teaching in secondary schools in Mombasa had acquired ICT skills through self-initiative in commercial computer colleges, while 30% had been trained on ICT skill through school sponsored workshops and 21% had trained on ICT skills in teacher training colleges. Teachers who received ICT training from teacher training colleges and workshops sponsored by the Kenyan Government through the Ministry of Education would most likely have been imparted with basic ICT skills as well as skills of integrating ICT into curriculum delivery. Therefore this finding implies that majority of the teachers (67%) with appropriate ICT infrastructure are likely integrate to ICT into their teaching of mathematics. This is because they have already been imparted with skills of imparting ICT into teaching.

4.2.2.7 Teachers’ Experience with ICT Tools

Teaching experience was considered as one of the determinants in teachers’ use of ICT in teaching Mathematics. Data on teachers’ years of experience in using ICT is presented on table 4.8.
### Table 4.8: Years of Experience with ICT

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 1 year</td>
<td>14</td>
<td>13.2%</td>
</tr>
<tr>
<td>1 – 5 years</td>
<td>75</td>
<td>68.8%</td>
</tr>
<tr>
<td>6 - 10 years</td>
<td>14</td>
<td>13.2%</td>
</tr>
<tr>
<td>Above 10 years</td>
<td>6</td>
<td>4.8%</td>
</tr>
<tr>
<td><strong>n=109</strong></td>
<td></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

The results of the study as shown on table 4.8 reveals that majority (87%) of the teachers had experience of more than a year of working with ICT tools. More than two thirds of the teachers (69%) indicated that they had used ICT devices for a period ranging from 1 – 5 years. This result reveals that majority of the teachers had wide experience in using ICT tools. Peralta and Costa (2007) argue that teachers with more experience with ICT tools have greater confidence in their ability to use them effectively. This finding therefore implies that with appropriate ICT environment in schools, most teachers are likely to use ICT in teaching mathematics. This could be attributed to increased confidence in using ICT as a result of long experience working with ICT resources.

#### 4.2.2.8 Teachers’ Access to ICT Tools at Home

Teachers’ access to ICT tools at home was envisaged in this study as an important element that could tilt either way their use of ICT in teaching. It was therefore interrogated in the study. Data on teachers’ use of computers and internet at home is presented on table 4.9.
Table 4.9: Teachers’ Access to Computer and Internet at Home

<table>
<thead>
<tr>
<th>Category</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer at home</td>
<td>(8)7.4%</td>
<td>(101)92.6%</td>
</tr>
<tr>
<td>Internet at home</td>
<td>(84)77.1%</td>
<td>(25)22.9%</td>
</tr>
</tbody>
</table>

The results of the study as shown on table 4.9 reveal that majority of the teachers did not have access to a computer at home. According to the study 93% had no computers at home while a paltry 7% had access to a computer at home. During the interview, some teachers reported that they lacked opportunities to practice skills they acquired during ICT training. This state of affairs could be attributed to the fact that majority of the teachers lacked access to a personal computer at home. Kamau (2012) found a significant relationship between computer ownership and teachers’ proficiency in ICT skills. He noted that computer ownership play a key role in improving proficiency in ICT skills. The present study found that computer ownership by the teachers was very low. This finding corresponds to previous studies that found low levels of computer ownership amongst teachers. For example, Mwangi (2014) and Kamau (2012) found low levels of computer ownership among secondary school teachers in Nairobi, Kiambu and Nyandarua counties.

Mwangi (2014) argues that computer ownership by teachers is an important indicator on their level of confidence in using computers. He further argues that teachers who own computers are more likely to hold ICT tools in high esteem as compared to their counterparts who don’t. This argument was also echoed by Afshari (2009) who observed that teachers who own computers at home were more confident in using computers than
those who did not own one. Mwangi (2014) further argues that computer ownership by teachers was an indication of availability of ICT tools beyond the precincts of the school settings. Nevertheless, the findings of this study revealed that majority of the teachers (77%) had access to internet at home. During the post-lesson-observation interview, teachers reported that they accessed the internet through mobile data services on their smart phones. This implies that the teachers were most likely to use internet in their teaching of mathematics. This could be attributable to the fact that they most likely had developed confidence in the use of the internet as a result of regular use at home.

4.3 Availability and Use of ICT Resources in Teaching Numeracy Concepts

The first objective of this study sought to establish whether ICT tools were accessible to teachers for the purposes of teaching numeracy concepts.

To achieve this objective, two sets of data were collected through teacher questionnaire, interview and observation of mathematics lessons. First, data was collected on availability of ICT resources in the schools. Second, the study sought to establish how these ICT resources were used to teach numeracy concepts in lower primary. Respondents were asked to describe availability of the following ICT resources in their schools: Desktop computers, laptops, tablets, projectors, scanners, printers, digital cameras, interactive whiteboards, mathematics software and internet facilities. The teachers responded to each of the items by ticking one of the following alternatives: not available, available in office, available in computer laboratory, available in classroom, and available in both office and computer laboratory.

The results on the availability of ICT resources are presented on table 4.10 below:
Table 4.10: Availability of ICT Resources in Schools

<table>
<thead>
<tr>
<th>Category</th>
<th>Not Available</th>
<th>Office</th>
<th>Computer Lab</th>
<th>Classroom</th>
<th>Computer Lab &amp; Office</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desksops</td>
<td>2.8%</td>
<td>18.3%</td>
<td>33.9%</td>
<td>0.0%</td>
<td>44.9%</td>
</tr>
<tr>
<td>Laptops</td>
<td>34.9%</td>
<td>20.2%</td>
<td>31.2%</td>
<td>2.8%</td>
<td>11%</td>
</tr>
<tr>
<td>Tablets</td>
<td>73.4%</td>
<td>1.8%</td>
<td>17.4%</td>
<td>4.6%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Projectors</td>
<td>22.9%</td>
<td>29.4%</td>
<td>45.0%</td>
<td>0.0%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Scanners</td>
<td>23.9%</td>
<td>36.7%</td>
<td>34.9%</td>
<td>0.0%</td>
<td>4.6%</td>
</tr>
<tr>
<td>Printers</td>
<td>0.9%</td>
<td>52.3%</td>
<td>21.1%</td>
<td>0.0%</td>
<td>25.7%</td>
</tr>
<tr>
<td>Digital cameras</td>
<td>59.6%</td>
<td>14.7%</td>
<td>25.7%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Interactive Whiteboards</td>
<td>94.5%</td>
<td>0.0%</td>
<td>5.5%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Internet</td>
<td>39.4%</td>
<td>18.3%</td>
<td>15.6%</td>
<td>12.8%</td>
<td>13.8%</td>
</tr>
<tr>
<td>Maths Software</td>
<td>57.8%</td>
<td>0.0%</td>
<td>42.2%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Table 4.10 indicates that all the schools that participated in the study were at least equipped with ICT tools. Nearly all the teachers who participated in the study indicated that they had desktop computers in their schools. Three quarters of the teachers indicated that there were laptops while approximately a quarter of the teachers indicated that there were tablets in their schools. Most of the teachers who indicated that their schools had laptops and tablets mainly hailed from public primary schools. This state of affairs could be attributed to the fact that the Kenyan Government was distributing laptops and tablets to selected public schools for its pilot phase. Forty percent (40%) of the teachers further indicated that their schools were equipped with digital cameras. Approximately two thirds of the teachers who participated in the study indicated that their schools had internet facilities. Likewise, two thirds of the teachers indicated that their schools had mathematics software specifically used for teaching and learning mathematics. Nearly all
the teachers who participated in the study indicated that their schools were equipped with printers, half of which were located in various offices in the schools. This implies that the devices were mainly used for official school functions besides being used for teaching and learning purposes.

Almost two thirds of the teachers indicated that their schools were equipped with scanners, most of which were installed in the offices and computer laboratories. The mere fact that the scanners were located in the computer laboratories implies that the gadgets were mainly used for teaching-learning purposes. Finally, 6% of the teachers indicated that their schools had interactive whiteboards. According to British Broadcasting Corporation [BBC] (2010) an interactive whiteboard is a flat plasma liquid crystal display (LCD) screen used for displaying images and information in digital format and it is basically operated by touching on the screen. Interactive whiteboard promotes creative interactive during classroom practice consequently motivating learners to effectively acquire concepts (BBC, 2010). During post-lesson observation interview, the study findings revealed that all the interactive whiteboards belonged to a few high-end private schools. None of the teachers from public primary schools reported that interactive whiteboards were available in their schools. This state of affairs could be attributed to the fact that interactive whiteboards are quite expensive to acquire and maintain.

The researcher conducted post-questionnaire lesson observations and teacher interviews to gather more detailed information on availability of ICT resources and their subsequent use in teaching mathematics. Seven out of 109 teachers in seven primary schools were involved in this second phase of the study. The findings from observations and interviews
conducted during this phase revealed that three public schools and four private schools were fairly well equipped with ICT devices for the delivery of mathematics curriculum.

Three schools from Mombasa County had been selected to be part of the 150 schools involved in the pilot phase of the Digischool Project. One of the schools located in Kisauni Sub-county received 110 tablets, the second school located in Mvita Sub-county received 111 tablets and the third school located in Changamwe Sub-county received 69 tablets. In total the county had received 290 tablets, all in proper working condition. All the tablets were luminous green in colour. One of the teachers interviewed reported that the tablets were solely meant to be used by the pupils in learning process. The tablets are denoted as Learners’ Digital Devices, acronyzed as LDD. In addition to the tablets, each of the three schools received two sky blue laptops for the teachers. The laptops were used as Teacher’s Digital Devices (TDD) as well as servers for the digital content that was already developed and pre-loaded with standard one and two curriculums. The digital content was developed by the Kenya Institute of Curriculum Development (KICD). The schools also received one projector, two digital content servers and a wireless router.

In total there were 290 tablets for pupils, 6 laptops for teachers, 3 projectors, 6 digital content servers and 3 wireless routers. The study revealed that all the gadgets delivered by the Kenyan Government for the school digital literacy programme were in proper working condition. This finding is consistent with Digischool (2016) assertions in the Daily Nation, September 7, 2016 that the Government of Kenya had already delivered ICT tools in the schools for the pilot phase of the digischool project. According to the
article, the government had already delivered luminous green tablets for the pupils, sky blue laptops for the teachers, a projector, digital content server and wireless routers.

The schools were also served with WiFi internet services provided by one of the major mobile telephone service providers in Kenya. The internet was provided free of charge for both teachers’ and pupils’ use for learning purposes. During the interview, teachers were asked to indicate whether they had internet in the school and if the internet was free of charge. In responding to this, one of the teachers had this to say:

“Yes, as you can see it’s provided by Airtel. It’s free of charge. The headmaster however controls its use. Teachers are also allowed to download teaching materials and lesson podcasts from YouTube.” [teacher in 3rd interview]

The study further found that the three public primary schools had also earlier benefited from a donation of laptops from United States Agency for International Development (USAID) Kenya. The schools had received each 48 blue-coloured laptops, two printers, a projector and two routers. In total, the schools had 144 laptops, 6 printers, 3 projectors and 6 wireless routers. However only 10 laptops in the 1st school, 30 laptops in the 2nd school and 38 laptops in the 3rd school were functional at the time of study. Therefore a total of 66 laptops were dysfunctional and were in a dire need of repair and software installation. All the ICT resources in the three public schools were located in the computer laboratory. Two of the schools had a desktop computer and printer installed in the head teacher’s office. The third school had no ICT device installed in the head teacher’s office.
Post-questionnaire observation and interview was also conducted in 4 private primary schools in the county whose teachers had indicated that they used ICT in teaching mathematics. In the first school, there were 46 desktop computers of which 37 were located in the computer laboratory, 4 were located in various offices and 5 were in the staffroom. Furthermore, there were 4 laptops of which one was located in the computer laboratory while three were in the offices including the head teachers office. The school had one printer installed in the headteacher’s office, one projector and two scanners in the computer laboratory. In addition the school had WiFi and fibre cable internet available everywhere for use by both teachers and learners. There was also a mathematics software installed in the computers. One of the teachers interviewed indicated that the software that was installed in the computers was Math Blaster. The teacher reported that the software enabled children to learn numeracy concepts through games and fun. The following is an excerpt of what the teacher had to say:

“Yes, in this school we use a mathematics software called Math Blaster. This particular software was selected because it enables children to learn mathematics through games and fun.” [teacher in 1st interview]

It was also revealed that this particular school maintained a second computer room for purposes of use by pre-school children. This ICT resource room was equipped with one laptop for the teacher’s use and 40 tablets for the pre-school children’s use. Older children were not allowed into this resource room according to the teacher who was interviewed during the study. The following is what the teacher reported:

“In this school we have a second ICT resource room equipped with tablets. This ICT resource room is strictly reserved for use by children in the pre-school section of the school. Older children are not permitted to use this room and teachers teaching in the primary section are allowed to use it only under
special circumstances with express permission from the headmaster." [teacher in 1st interview]

The second private school was found to be equipped with 20 desktop computers for learning purposes in the computer laboratory. Further, there were 20 more desktop computers still packed in boxes unused but stored in a corner of the computer laboratory. There were also 2 projectors, a printer and a digital camera in the computer laboratory. In addition, there were 5 desktop computers and 3 laptop computers located on various offices in the school for the official use. The school provided WiFi internet that covered the entire compound. There was internet in offices, classrooms, the staffroom, computer laboratory and a few designated areas on the school compound. A WiFi password was required to access the internet services. The researcher observed that most of the teachers in the school who had no classroom engagement were engrossed on their tablets and smart phones surfing the internet.

The third private primary school in which post-questionnaire observation and interviews were conducted was adequately endowed with ICT resources for instructional purposes. The school had 10 desktop computers, 40 laptop computers, 30 tablets, 2 projectors, 2 scanners, 2 digital cameras, a printer, photocopying machine and 8 wireless routers all installed in two ICT resource rooms. One of the ICT resource rooms was designated for children in the lower primary section of the school while the other one was designated for learners in the upper primary section. The ICT resource room designated for use by pupils in the upper primary was further installed with an interactive whiteboard. The school had 10 desktop computers in various offices and 15 desktop computers in the staffroom. The school further had internet in the offices, staffroom, classrooms and the
ICT resource rooms. The offices were served with fibre cable internet while the staffroom, classrooms and ICT resource rooms had WiFi internet. The teachers and children were allowed to use the internet but responsibly according to one of the teachers interviewed. Here is what the teacher had to say:

“Both the teachers and learners are allowed to use internet in the school. Teachers are however not allowed to use internet during class time. The school does not also allow surfing certain sites on the internet with offending materials such as pornography or prostitution. There is a proxy server that controls material and sites on the net that internet users in school surf.”

[teacher in 3rd interview]

The fourth private school in which observations and interviews were conducted had 30 desktop computers, 35 laptop computers, a projector, scanner, printer, an interactive whiteboard and 2 wireless routers all located in a spacious computer laboratory. There were also 3 desktop computers, a printer and photocopying machine located in various offices in the school. There were also 2 desktop computers in the staffroom. Furthermore, there was WiFi internet and cable internet in offices, staffroom, computer room and classrooms.

Table 4.11 summarizes the total number of ICT resources present in seven (3 public and 4 private) primary schools in which lesson observations and teacher interviews were conducted during the second phase of the study.
Table 4.11: A Summary of ICT Resources Available in Schools

<table>
<thead>
<tr>
<th>ICT Resource</th>
<th>Public</th>
<th>Private</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktops</td>
<td>2</td>
<td>161</td>
<td>163</td>
</tr>
<tr>
<td>Laptops</td>
<td>150</td>
<td>82</td>
<td>232</td>
</tr>
<tr>
<td>Tablets</td>
<td>290</td>
<td>70</td>
<td>360</td>
</tr>
<tr>
<td>Projectors</td>
<td>6</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Scanners</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Printers</td>
<td>5</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Digital cameras</td>
<td>6</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Interactive Whiteboards</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Wireless routers</td>
<td>6</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>Photocopy</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 4.11 indicates there were a sum of 163 desktop computers, 232 laptops and 360 tablets in the 7 primary schools that were visited in the 2nd phase of the study. This reveals that the tablets were the most prevalently used ICT devices for instructional purposes. According to Becta (2005) tablets are popular because of their safe and fast wireless network that facilitates easy access to knowledge as well as support learning. Calder and Larkin (2016) argue that although mobile ICTs such as tablets and smartphones are relatively new on the ICT landscape, they offer fresh opportunities for re-envisioning mathematics learning experiences by enhancing students' engagement and mathematical thinking.

According to Calder and Larkin (2016) tablets provide both visual and dynamic affordances in the course of learning mathematics. Calder and Larkin also argue that
Tablets are embedded with touch screens which encourage learners to actively interact with them during mathematics learning. Tablets also allow for easy transformation of different learning situations as well as providing learners with more flexible ways of working together collaboratively (Calder and Larkin, 2016).

The findings of this study indicate that majority of the tablets were located in the public primary schools. This could be attributed to the then on-going distribution of tablets in public schools for the implementation of the Digischool Project. Laptops were found to be the second most prevalent ICT tools to be used in the schools, followed in the third position by desktop computers. This implies that desktop computers as digital learning devices are being gradually replaced by more portable mobile digital devices such laptops and tablets.

Although the present study found that some of the schools in Mombasa County were adequately endowed with ICT resources for integration in teaching – learning processes, majority of the schools were not adequately equipped with ICT resources for meaningful use in teaching mathematics. This finding is consistent with previous studies in Kenya that found out there was inadequate ICT infrastructure in the schools. For example, Mogire (2013) found that majority of secondary schools in Kisii County had been inadequately equipped with computers. He noted that there was no software for teaching mathematics. Likewise, Florida (2011) found that only 33% of secondary schools in Narok and Bomet counties had been equipped with computers. Lack of computers was cited as a major hindrance in the use of ICT for teaching mathematics. Plomb, Anderson, Law, and Quale (2009) argue that access to ICT tools in schools is an important condition
in the adoption and use of ICT for learning purposes. Wanjala et al. (2015) found that secondary school teachers in Bungoma were inadequately equipped with computer hardware and software which conversely hampered their use of ICT in teaching mathematics. The study found a strong relationship between teachers’ accessibility to ICT hardware and software and their subsequent use of ICT in teaching mathematics (Wanjala et al., 2015). They however noted that accessibility to ICT tools was not a better predictor of teachers use of ICT in teaching mathematics.

4.3.1.0 Use Of ICT in Teaching Numeracy Concepts

The first objective of this study further sought to establish whether teachers actually used ICT devices at their disposal in teaching numeracy concepts. To achieve this objective, quantitative data on the use of ICT in teaching numeracy concepts was gathered through the self-administered Teacher Questionnaire. Further, in-depth data was gathered qualitatively using video-recorded lesson observations and voice-recorded teacher interviews.

4.3.1.1 Quantitative data on Teachers’ Use of ICT in Teaching Numeracy Concepts

To collect these data, the teachers were asked to respond to ten statements describing their current use of ICT in teaching numeracy concepts. The teachers responded by ticking one of the following alternatives: Never used at all, once per term, once per month, once per week, a few times a week and daily. These alternatives were collapsed into three categories for the sake of data analysis as follows: Never used at all, Not used on a daily basis and Used on a daily basis.
Table 4.12 presents the results of the study on use of ICT in teaching numeracy concepts.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Never Used</th>
<th>Not Used Daily</th>
<th>Used on Daily Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using ICT to teach numeracy concepts</td>
<td>82.6%</td>
<td>13.7%</td>
<td>3.7%</td>
</tr>
<tr>
<td>Using ICT to supplement numeracy skills teaching</td>
<td>79.8%</td>
<td>18.4%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Using ICT to promote creativity in numeracy skills</td>
<td>84.4%</td>
<td>14.7%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Using ICT to teach number operations</td>
<td>81.6%</td>
<td>18.4%</td>
<td>0%</td>
</tr>
<tr>
<td>Using ICT to analyze information and make conclusions</td>
<td>82.6%</td>
<td>17.4%</td>
<td>0%</td>
</tr>
<tr>
<td>Using ICT to search the internet</td>
<td>69.7%</td>
<td>22.9%</td>
<td>7.4%</td>
</tr>
<tr>
<td>Using ICT to create concrete numeracy activities</td>
<td>82.6%</td>
<td>16.5%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Using ICT to create images and sound in numeracy concepts (multimedia)</td>
<td>81.7%</td>
<td>17.4%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Using ICT to promote interaction during mathematics lesson</td>
<td>83.5%</td>
<td>16.5%</td>
<td>0%</td>
</tr>
<tr>
<td>Using ICT in lesson preparations</td>
<td>82.6%</td>
<td>15.6%</td>
<td>1.8%</td>
</tr>
</tbody>
</table>

The results as shown on table 4.12 reveal that majority (83%) of teachers teaching in the lower primary schools in Mombasa County do not use ICT devices to teach numeracy concepts. Only 17% indicated that they used ICT devices at their disposal to teach
It became apparent during the second phase of the study that the 17% who integrated ICT in their teaching of mathematics hailed from 7 primary schools. Furthermore, an insignificant number (4%) of the teachers indicated that they used ICT tools on a daily basis to teach numeracy concepts. The rest (13%) of the teachers who used ICT tools to teach numeracy skills reported that they did not use them on a daily basis as it would have been expected.

The study findings revealed that some of the teachers only used ICT tools once in a term, some other teachers used ICT only once a month while the rest of the cohort used them on a weekly basis. This finding is in agreement with previous studies done elsewhere in Kenya. For example Mwangi (2014) in his study of secondary schools in Nairobi and Kiambu counties, found that teachers’ use computers for delivery of the curriculum was inadequate. His study findings revealed that the computers in schools were mainly used to teach basic computer skills to students. Similarly, Kamau (2012) found there was limited use of ICT in the teaching-learning processes in secondary schools in Nyandarua County. Likewise, Mbathe (2014) found that there was inadequate use of ICT tools in the teaching of mathematics in public primary schools in Thika, Kiambu County.

UNESCO (2002) classifies schools in which ICT is barely used for curriculum delivery but for impartation of ICT skills as being at the emerging phase of ICT integration. According to Wabuyeleye (2003; as cited in Mwangi, 2014) most schools in Kenya are still beleaguered at the emerging stage of ICT integration in education. Some of the teachers interviewed noted that it was difficult to use ICT tools on a daily basis in the teaching of mathematics. Here is what one of the teachers had this to say:
“I can’t use computers to teach numeracy concepts daily because their use calls for a lot of advance preparation which is time consuming. A lot of time is required in preparing and pretesting of ICT based lessons. If I have to do this on a daily basis, then I would end up wasting a lot of valuable class time. I may never be able to cover the syllabus.” [teacher in 2nd interview]

This sentiment was shared by most of the teachers who were interviewed. The study revealed that in most of the schools, ICT devices were used in computer laboratories. This meant that children had to keep moving from their classrooms to the computer laboratories and back to their classes after the lessons consequently resulting in wastage of valuable teaching-learning time. Most of the teachers suggested that ICT devices should be used in classrooms instead of laboratories in order to salvage valuable time lost in movements. Infact one of the teachers who regularly used ICT tools in teaching reported that she mostly used ICT devices to teach numeracy skills right inside the classroom. The following is an excerpt of what the teacher reported:

“Tablets and laptops in this school are stored in movable cabinets inside the computer laboratory. These cabinets are very useful especially when using the devices in the classroom instead of the laboratory. The cabinets have inbuilt charging units for the devices, so they are simply wheeled into the classroom, used and then safely wheeled back into the laboratory for storage.” [teacher in 5th interview]

The plausibility of using the ICT tools in the classrooms increased their frequency of use in classroom instruction. The study found that confining ICT use to computer laboratories was not only an intricate challenge but was also a barrier to effective use of ICT in teaching mathematics. This was compounded by the fact that most schools had only one computer laboratory. Therefore only one class could use ICT tools at a given time. One of the teachers interviewed reported that she did not use ICT tools as often as it was expected because the school had only one computer laboratory that was supposed to be shared by all. The following is an excerpt of what the teacher had to say:
“I do not use ICT on a daily basis in the teaching of numeracy concepts. This is because there is only one computer laboratory in the school and it’s supposed to be used by all the teachers and pupils. It’s quite chaotic when it comes to using the computer laboratory. There is no timetable put in place to regulate its use. It’s often used on a first-come-first-served basis. Some children benefit more from the facility than others and that is quite unfair.”
[teacher in 4th interview]

This finding is in agreement with previous studies. For example, Mwangi (2014) found that most of the computers in secondary schools in Nairobi and Kiambu were located in the computer laboratory. According to Swain and Pearson (2001) solely placing computers in a laboratory was one of the major barriers hindering their use in teaching and learning processes. They argued that placing ICTs in a laboratory resulted in limited access to the ICT resources. Mwangi (2014) asserts that computer laboratories are normally treated as ‘extra’ or ‘special’ facility instead of being viewed as an integral part of teaching-learning process.

The findings of this study further revealed that there was limited use of internet for instructional purposes in the schools. Despite the majority (61%) of the teachers indicating that they had adequate access to internet in their schools, only a paltry (7%) used the internet services for instructional purposes on a regular basis. Nearly a quarter (23%) of the teachers indicated that they used the internet to search for teaching-learning materials although not a regular basis. The findings of the present study are consistent with findings from previous studies done in Kenya. For example, although majority (73%) of secondary school teachers in Nairobi and Kiambu reported that their school had internet facilities, only 2% of their students indicated that they actually used internet in school for learning purposes (Mwangi, 2014). Likewise, despite all the secondary school teachers in Weslands overwhelmingly reporting availability of internet in their schools,
its use in teaching business studies was limited (Kamene, 2014). The study found that only a quarter of the participants (25% of teachers and 28% of students) indicated that they actually used the internet for teaching-learning purposes. Therefore internet use in most schools in Kenya could still be at the emerging phase of the UNESCO (2002) Model of ICT integration in classroom practice. However, some of the teachers interviewed reported that they used the internet to download instructional materials and lesson podcasts from YouTube. This finding is in agreement with a previous finding by Mwangi (2014) that secondary school teachers in Nairobi and Kiambu downloaded instructional materials and stored them on VCDs and DVDs.

Finally, the study results as indicated on table 4.13 revealed that some teachers used ICT to supplement their teaching of mathematics concepts. They also used it to teach number operations, analyze information and make conclusions, create concrete learning activities, create sound and image effects, promote interaction in class as well as for lesson planning.

4.3.1.2 Qualitative Data on Teachers Use of ICT to Teach Mathematics
Post-questionnaire lesson observations and teacher interviews revealed how teachers used ICT devices to teach numeracy concepts. The researcher observed seven mathematics lessons taught by seven teachers in seven schools. The study revealed that the laptops and tablets distributed to the public primary schools by the Government of Kenya had been pre-loaded with digital content for class one and two according to the national curriculum guidelines. This finding is consistent with ICT Authority (2016) assertion that the digital devices distributed in schools were pre-loaded with interactive e-content for
standard one and two in five subjects including mathematics. The following mathematics topics were pre-loaded in the ICT tools delivered to public schools: Pre-number activities, whole numbers, addition and subtraction, measurements (length, mass, money and time), Lines (straight and curved lines) and shapes (rectangles, triangles and circles). These mathematics concepts were demonstrated in a game setting using multimedia features such as text, numbers, images, sound and motion pictures.

4.3.2.0 Teaching of Various Mathematics Concepts

This discusses the basic mathematics concepts taught in lower lower primary using ICT tools. The following concepts were covered using ICT devices in the classroom: whole numbers, classification, addition, subtraction and measurement.

4.3.2.1 Whole Numbers

The following is a discussion of how numeracy concepts were organized in the program: Pre-numbers activities included classification, sorting and grouping, pairing and matching, and ordering and sequencing. The topic of whole numbers involved reading and writing whole numbers in words and symbols ranging from numbers 1 - 10. The program commenced with a cartoon which appeared on the screen and immediately started reading numbers when prompted by pressing the play button on the screen. Every time the cartoon reads a number, that number got displayed in a dialogue box on the screen. In another activity, a motion image of a group of ten children standing in a circle appeared on the screen singing numbers one to ten.

They sang a popular and familiar song that went as follows, “I am number one…” The following is a transcription of the song:
“I am number one, I have come to dance, dancing in the middle and then I run away. I am number two, I have come to dance, dancing in the middle and then I run away. I am number three, I have come to dance, dancing in the middle and then I run away. I am number four, I have come to dance, dancing in the middle and then I run away. I am number five, I have come to dance, dancing in the middle and then I run away.” [ song pre-loaded in Digischool tablets]

The song went on and on until the counting reached number ten. Every time a number is mentioned in the song, a child enters the circle, dances in the middle and then sprints out of the circle when the children sing, “and then I run away.” It was quite an invigorating experience and the researcher observed that children really enjoyed it. They even enjoined in the song and sang together. This is a common and popular song with children. It is commonly used in teaching numbers in a conventional mathematics learning environment. However, it was able to afford a new experience in teaching numeracy concepts through the use of ICT infrastructure.

4.3.2.2 Teaching the Concept of Classification

In a sorting activity, a child was asked to sort pictures of the following objects with assortment of colours: cats, huts, dogs, cars, boys with shirts against boys with pullovers, and a variety of fruits. In the first activity, children were asked to group the following stationeries: rubbers, books, pencils and rulers. In the second activity, children were asked to drag pictures of objects with similar characteristics such as colour and shapes in a box.

4.3.2.3 Teaching the Concept of Addition

The program began the discussion of addition of whole numbers by defining the word addition as “putting together.” A number of objects were used to illustrate the process of addition. For example digital images of cows were used to demonstrate the process of
addition operations. The program also involved a segment that demonstrated to children how to add objects in bundles of tens. The program used a story of a monkey who was very happy after receiving many bundles of sweets as birthday gifts. The monkey had received nine (9) bundles of sweets in which each bundle consisted of ten sweets. The monkey was then seen requesting children to help him count the number of sweets he had received. The researcher observed one of the teachers using a similar podcast in teaching the concept of adding tens. The following is a transcription of what the monkey said in the podcast:

“Am happy for the bundles of birthday gifts that you have given me. Help me to count how many sweets I have received all together. First bundle is ten, second 20, third 30, forth 40, fifth 50, sixth 60, seventh 70, eighth 80, and finally ninth 90. So how many sweets do I have? I have received ninety sweets all together.” [podcast preloaded in the Digischool tablets]

This podcast was so useful and effective in helping the teacher develop the concept of adding tens. It provided concrete experiences that enabled children learn how to add tens. One of the teachers interviewed noted that the program was quite helpful to children in understanding the concept of adding tens. “It is a pre-requisite activity for teaching addition of two digit numbers,” reported one of the teachers.

4.3.2.4 Teaching the Concept of Subtraction

The next topic discussed in this basic numeracy program was subtraction of whole numbers. The discussion commenced with the definition of the word subtraction as take-away. Similarly pictures were used to illustrate the process of subtraction of whole numbers. For instance, a motion picture of ten green bottles hanging on a wall were seen.
One green bottle is seen dropping leaving nine still hanging the wall. The following is a transcription of what a voice is heard saying in the background:

“Ten green bottles are hang on a wall. Unfortunately one bottle falls down and breaks into pieces. How many bottles are remaining on the wall?”

In another activity used to demonstrate subtraction, four elephants were seen appearing on the screen and then two were crossed. Children were then asked to say the number of elephants which were not crossed. Figure 4.2 below shows images of elephants used to illustrate subtraction procedure.

![Elephant Image]

**Figure 4.1: Illustration of Subtraction Process Using Images of Elephants**

### 4.3.2.5 Teaching the Concept of Measurement

The next basic mathematics concept to be discussed was **measurement** and it included length, mass, time and money. Length was first defined as, “how long or short an object was.” Then two objects were displayed on the screen and children were asked to identify a long object from a short one. The children were asked to compare two objects by using such statements as “longer than” or “shorter than.” For example, the following objects shown on figure 4.3 were used.

**A** 

**B**

**Figure 4.2: Objects Demonstrating Difference Lengths**
A voice is heard in the background saying:

"Which one of the two rods is longer than the other? Object A is longer than B and Object B is shorter than A."

A variety of other pictures representing different objects were presented where one object was always longer than the other. Straight and curved lines concepts were also discussed under the concept lines. Finally children learnt about rectangles, triangles and circles under the concept shapes. For every concept, the programme discussed definitions of key terms first, then development of mathematics concepts through games and assignments and finally revision by use of self-correcting question item. According to one of the teachers interviewed, children use tablets to learn mathematics in three main ways. First, they learnt through play and games. The games were fascinating and fun to children. Second, they took assignments on the same topic and third, they undertook revision exercises which involved the use of self-correcting question items. During the interview, the researcher asked teachers to indicate how they used tablets to teach numeracy concepts. In responding to this question, below is an excerpt of what one of the teachers from a public school had to say:

"The teachers’ laptops and pupils’ tablets came preloaded with learning programmes. The first programme Netsupport system was developed by Moi University and the second is Content Hub, developed by KICD. The two systems work in collaboration with each other. The netsupport system helps the teacher to manage the class. It is the teacher’s partner in matters of class management. It registers all pupils’ tablets that are currently active in class. It also helps the teacher to send assignments to pupils, collect them back, mark, give feedback and record marks. Furthermore, it helps the teacher to send new content to pupils or modify the content already preloaded in the tablets in order to suit the learners’ needs. It is also handy in helping the teacher to develop a lesson plan and use it in class. In addition, it helps in controlling children’s use of tablets as well as in managing learning
activities. As for the content hub programme, it contains all the digital content that was developed by KICD” [teacher in 7th interview]

In support of the notion that the netsupport programme which came pre-loaded with the tablets helped teachers to manage learning activities in their classrooms, here is what a teacher from a different public school had to say:

“There are two main ways of controlling children using netsupport system. The teacher can use the system to either lock the tablets or blank them out in order to attract children’s attention. Locking the tablets means making them inactive, so they don’t respond to children’s touch. Blanking them out means turning the screen blank and dark.” She demonstrates for the researcher to see. “Once children’s devices are locked or blanked out, they begin seeking teacher’s attention and help. At this point the teach can now explain or demonstrate something with their full attention.” [teacher in 1st interview]

The teachers interviewed from private schools reported that they were not aware of the interactive digital content developed by KICD. Asked how they used ICT to enhance development of basic mathematics concepts, they reported that ICT enabled them to develop interactive mathematics activities. One teacher reported that ICT enabled children to learn mathematics through games and fun. The teacher noted that the mathematics programme installed in the pupils’ computers encouraged self learning by giving learners immediate feedback. The programme allowed each and every child to progress at his/her own pace. Here is what one teacher had to say:

“The mathematics software used in this school allows pupils to learn mathematics through games. Look at this...(she shows the researcher a programme where images of cows with assorted colours are used to demonstrate a subtraction operation. A voice from the background gives instructions on how subtraction is done through animated images). You see, this software uses media from real life experiences that any child can easily follow while learning mathematics operations.” [teacher in 1st interview]
Most of the teachers interviewed reported that they used projectors to demonstrate basic mathematics concepts to children. In one of the lessons that the researcher observed, a teacher was working on a mathematics problem on a laptop while projecting it on a screen in the computer laboratory for all the children to see. This technique allowed for a discussion to ensue among pupils as most of them attempted to imitate the teacher’s actions on their tablets. The teacher demonstrated to them the procedure of sorting and grouping of objects by dragging and dropping techniques. The following is an excerpt from the 7th lesson observation involving a conversation between two pupils and their teacher:

Jane: Mine is not working (referring to her tablet)
Peris: Look, mine is moving. Jane is not doing it well
Jane: Please teacher show me how to move the objects
Peris: Let me show you (she picks Jane’s tablet and attempts to drag the object but it did not respond)

Teacher 7: Let me see (she attempts a second time to drag it but the object doesn’t move). This one doesn’t work.

Teacher 7: (Gives Jane a new tablet) Try this
Jane: (To her friends happily) This one is moving. “I like it, I like it.”

ICT tools were also used to search for information on the internet for instructional purposes. Most of the teachers reported that they used school internet to download instructional materials. Some teachers reported that they downloaded video-recorded episodes and used them to teach numeracy concepts. One of the teachers in a private school noted that she used the internet to download the interactive digital content available on the KICD portal at http://www.kicdinteractivecontent.ac.ke. The researcher later confirmed that the content found at this portal was the same as the digital content
pre-loaded in the tablets delivered to the public schools. This finding is consistent with ICT Authority’s (2016) claim that KICD was working towards getting the digital interactive content available on multiple platforms for all the children and teachers to access the materials. One way of doing this was placing the content on its portal.

4.3.3 Relationship Between Availability and Use of ICT in Teaching Mathematics

The study sought to establish whether availability of ICT tools in schools significantly influenced teachers’ use of ICT in teaching mathematics. The study found that desktop computers, laptops and tablets were the most prevalent ICT tools in schools in Mombasa County. The researcher therefore sought to investigate whether there were differences in use of ICT tools in teaching mathematics. Subjects were divided into four groups on the basis of availability of desktop computers, laptops and tablets for teaching numeracy concepts. Table 4.13 shows data on means in the use of various ICT tools in teaching numeracy concepts.

<table>
<thead>
<tr>
<th>Availability of ICT Tool</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>23</td>
<td>0.00</td>
<td>0.000</td>
</tr>
<tr>
<td>Desk Top Computer</td>
<td>49</td>
<td>0.51</td>
<td>1.003</td>
</tr>
<tr>
<td>Laptop</td>
<td>20</td>
<td>2.46</td>
<td>1.744</td>
</tr>
<tr>
<td>Tablet</td>
<td>8</td>
<td>4.25</td>
<td>0.707</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>1.01</td>
<td>1.599</td>
</tr>
</tbody>
</table>

The results in table 4.13 indicate that the use of tablets in teaching numeracy concepts was much higher at mean (M) of 4.25 and standard deviation (SD) of .7 as compared to
laptops at $M=2.46$ and $SD=1.7$ and desktop computers at $M=0.51$ and $SD=1$. As was expected the teachers who had no access to either laptops, tablets or desktops did not use ICT to teach numeracy concepts ($M=0.00$, $SD=0.000$). These results indicate that there was more use of tablets in teaching numeracy concepts than the laptops and desktop desktop computers. The study findings indicate that at the scale of 5.00 the use of tablets in teaching numeracy concepts stood at a mean of 4.25. The use of desktop computers for the purposes of teaching numeracy concepts was so minimal the mean of 0.5 out of a scale of 5.0.

Figure 4.1 depicts a mean plot graph showing means in the use of various ICT tools in teaching mathematics.

![Figure 4.3: Mean Plot on Use of ICT in Teaching Mathematics](image-url)
The Mean Plot in Figure 4.1 shows that the use of tablets in teaching numeracy concepts was much higher than laptops and desktops. The use of desktops in teaching numeracy concepts as shown on the mean plot graph was very dismal.

One Way ANOVA between groups technique was utilized to test whether the differences in the means in Table 4.13 were significant. The hypothesis that was tested is as follows:

\[ H_0: \text{There is no significant difference in the use of ICT in teaching numeracy concepts between teachers who have access to ICT resources and those who do not.} \]

Table 4.14 shows the results of One Way ANOVA test on difference in the means in the use of ICT tools in teaching numeracy concepts between groups of teachers who had access to tablets, laptops, desktop computers, and those who had no access at all.

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>143.445</td>
<td>3</td>
<td>47.815</td>
<td>41.903</td>
<td>.000</td>
</tr>
<tr>
<td>Within Groups</td>
<td>109.545</td>
<td>96</td>
<td>1.141</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>252.990</td>
<td>99</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The mean differences are significant at the 0.05 level

Table 4.13 indicates that the calculated value \( P = 0.00 < 0.05 \) with a calculated \( F = 41.903 \) at 3 df (degrees of freedom). These results show that there was a statistically significant difference at the \( P \) value (0.00) less than the critical value (0.05). The results also indicate that the \( F \) statistic (41.903) was significant. Therefore the difference in means was found to be significant and the null hypothesis was thus rejected on the basis of these results. This finding implies that there is a significant difference in the use of ICT in teaching numeracy concepts among teachers depending on the available ICT.
tools. There was a significant use of ICT to teach numeracy concepts when tablets were provided to the teachers. The findings indicate that there was minimal use of ICT in teaching numeracy concepts when teachers were only provided with desktop computers. There was however substantial use of ICT in teaching numeracy concepts with the provision of laptops for teaching purposes. The study finding therefore suggest that availability of tablets and laptops in schools significantly influenced teachers’ use of ICT in teaching numeracy concepts.

To determine the effect size of using different ICT tools in teaching numeracy skills, eta squared was computed. Eta squared is calculated by dividing the sum of squares for between groups by the total sum of squares in the ANOVA table (Pallant, 2005). Table 4.14 indicates that sum of squares between groups is 143.445 and total sum of squares is 252.990. Therefore (143.445) divided by (252.990) results in (0.567). Therefore the size effect (eta squared) for using different ICT tools to teach numeracy concepts was found to be .57. According to Cohen’s (1988) classification of effect size, .57 would be considered large effect size. This could be interpreted to mean that approximately 57% of the use of ICT teaching numeracy concepts could be attributable to the type of ICT tools provided to teachers in the school. The study results shown on Table 4.13 indicates that provision of tablets and laptops encouraged teachers to use ICT more than provision of desktop computers. The findings also revealed that the use of desktop computers in teaching numeracy concepts was not significant.
Further, Post-hoc multiple comparisons using Tukey HSD test was performed to establish which groups of teachers were significantly different in their use of ICT in teaching numeracy concepts. Table 4.15 presents the results of post-hoc analysis test:

Table 4.15: Post Hoc Comparisons on Teachers’ Use of ICT in Teaching Numeracy Concepts Using Tukey HSD Test

<table>
<thead>
<tr>
<th>(I) Availability Of ICT</th>
<th>(J) Availability Of ICT</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower Bound</td>
<td>Upper Bound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DESK TOP</td>
<td>NONE</td>
<td>-.510</td>
<td>.270</td>
<td>.239</td>
<td>-1.22</td>
</tr>
<tr>
<td>LAPTOP</td>
<td>NONE</td>
<td>-2.100</td>
<td>.327</td>
<td>.000</td>
<td>-2.95</td>
</tr>
<tr>
<td>TABLET</td>
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<td>-4.250</td>
<td>.438</td>
<td>.000</td>
<td>-5.40</td>
</tr>
<tr>
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<td>.510</td>
<td>.270</td>
<td>.239</td>
<td>-.20</td>
</tr>
<tr>
<td>LAPTOP</td>
<td>TABLET</td>
<td>-1.590</td>
<td>.283</td>
<td>.000</td>
<td>-2.33</td>
</tr>
<tr>
<td></td>
<td>DESK TOP</td>
<td>-3.740</td>
<td>.407</td>
<td>.000</td>
<td>-4.80</td>
</tr>
<tr>
<td>LAPTOP</td>
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<td>2.100</td>
<td>.327</td>
<td>.000</td>
<td>1.25</td>
</tr>
<tr>
<td>TABLET</td>
<td>DESK TOP</td>
<td>1.590</td>
<td>.283</td>
<td>.000</td>
<td>.85</td>
</tr>
<tr>
<td></td>
<td>LAPTOP</td>
<td>-2.150</td>
<td>.447</td>
<td>.170</td>
<td>-3.32</td>
</tr>
<tr>
<td></td>
<td>NONE</td>
<td>4.250</td>
<td>.438</td>
<td>.000</td>
<td>3.10</td>
</tr>
<tr>
<td>TABLET</td>
<td>DESK TOP</td>
<td>3.740</td>
<td>.407</td>
<td>.000</td>
<td>2.67</td>
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<tr>
<td></td>
<td>LAPTOP</td>
<td>2.150</td>
<td>.447</td>
<td>.170</td>
<td>.98</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.

The results of Post Hoc comparisons using Tukey HSD test as shown on table 4.15 indicate that there was significant difference in in the means in use of ICT in teaching numeracy concepts between teachers who were provided with tablets, laptops and desktop computers. Groups of teachers provided with tablets and laptops did not differ significantly in their use of ICT in teaching numeracy concepts. However, groups of teachers with tablets and laptops differed significantly in use of ICT in teaching mathematics with the group that had desktop computers. Interestingly, the results of post
Hoc analysis indicate that there was no significant difference in means of using ICT to teach mathematics between the group of teachers that had desktop computers and the group without access to ICT tool for teaching. These findings imply that providing tablets and laptops to teachers in schools significantly influenced their use of ICT in teaching numeracy concepts. The findings however revealed that providing desktop computers for teaching purposes did not significantly inspire teachers to use ICT in teaching numeracy concepts.

This finding is in agreement with previous studies which found a strong positive relationship between the frequency of use of ICT in teaching and the number of ICT tools available in the classroom (Becker & Ravitz, 2001; Norris et al, 2003). Inan and Lowther (2010) argued that availability and accessibility of ICT tools in the school directly and indirectly influenced teachers’ ICT use in the classroom. Similarly, Cubukcuoglu (2013) posited that teachers were in a better position to use ICT in teaching if they had adequate opportunities to get full access to high quality ICT resources. Cubukcuoglu (2013) argues that teachers can easily use ICT tools in their teaching if good and well designed ICT infrastructure were present in their schools.

The findings of this study also agree with previous findings from studies done elsewhere in Kenya. For example, Karimi (2012) found that despite majority (88%) of secondary school teachers in Muranga reporting availability of computers in their school, there was limited pedagogical use of ICT in classroom instruction. Likewise Mwangi (2014) found that despite the availability of about 800 desktop computers in secondary schools in Nairobi and Kiambu, there was minimal use of those computers in teaching mathematics.
In majority of the schools, the computers were mainly used for teaching basic computer skills rather than for the delivery of the school curriculum.

This finding is consistent with findings from Plomb, Anderson, Laws & Quale (2009) study which indicate that availability and accessibility to ICT tools by teachers in schools is a necessary condition for their use in the classroom instruction. Likewise, Wanjala et al (2015) found that there was a significant relationship between availability of computers and their use in teaching mathematics. Furthermore, Abdallah, Abidin, Luan, Majid and Atan (2006) found that providing teachers with laptops, projectors and computer software motivated them to use ICT for teaching and learning purposes. In agreement with this argument, Mumtaz (2000) asserted that access to sufficient quantities of ICT tools encouraged teachers to use them for teaching purposes.

The findings of the study is also congruent with the study conducted by Buabeng-Andoh (2012) which found that access to ICT infrastructure and resources in schools was a necessary condition in the adoption and use of ICT into classroom practice. He argued that effective use of ICT in teaching mainly depended on availability and accessibility to ICT resources in the schools. However, availability of ICT resources in the classroom alone could not be enough in sustaining effective use of ICT in teaching, but the use of suitable ICT tools and programs that support teaching and learning.

4.4 The Impact of ICT Tools on Teaching of Numeracy Concepts

The second objective of the study sought to establish whether teachers’ use of ICT empowered them to teach numeracy concepts better. To gain insights into this objective,
the researcher collected qualitative data by observing mathematics lessons in progress as well as interviewing teachers who had indicated on their questionnaire that they used ICT to teach mathematics. The researcher observed seven mathematics lessons in seven different lower primary schools. The researcher further conducted post-lesson observation and teacher interview with an aim of seeking clarifications and gaining deeper information. Out of the seven schools in which observations and interviews were conducted, three were public and four were private schools. Coincidentally, the three public primary schools selected happened to be part of the 150 schools targeted for the pilot phase of the National Digital Literacy Programmed (NDLP).

The transcription of data from video-recorded observations and voice-recorded interviews was done according to a model proposed by Powell et al. (2003) which involves seven-phase process of data transcription as follows: Viewing the video-recorded and listening to the voice-recorded data familiarize self with the materials; describing the video and voice data in textual format, identifying critical events; transcribing data to produce probable transcripts; and finally coding the data to identify themes that emerge from the data.

Eleven themes emerged from the data coding process as follows: ICT is a break from routine (BFR), it produces interactive learning styles (ILS), it reduces pupil weakness (RPW), and makes mathematics to become attractive (MBA) as well as increasing pupil engagement (IPE). ICT was also found to facilitate classroom activity (FCA), raise pupil attention (RPA), increase pupil concentration (IPC), promote learner autonomy (PLA), improve Pupil’s memory (IPM), and increase class attendance (ICA).
The eleven themes were further categorized into two broad themes: Effective classroom management and cognitive amplification. The broad theme effective classroom management concerns orchestration on the classroom environment thereby making it conducive for learning. Chrysanthou (2008) found that the use of ICT in teaching mathematics brought about positive changes in the classroom environment. Under this broad theme effective classroom management, the researcher included the following themes: Break from routine, interactive learning styles, increase pupil engagement, facilitate classroom activity and increase class attendance. The broad theme cognitive amplification concerns enhancement and reinforcement of mathematics learning. Pea (1985) argues that ICT provides learners with powerful cognitive tools that enable them to enhance their ability to construct knowledge by opening up new possibilities of thought and action. Under the broad theme cognitive amplification, the researcher included the following themes: Mathematics becomes attractive, raise pupil attention, increase pupil concentration, promote learner autonomy and improve pupil memory. The broad themes and sub-themes that emerged from the study are discussed as follows:

4.4.1.0 Influence of ICT on Effective Classroom Management

Under this broad theme, categories that were related to the functioning and operations of the learning environment were placed. Therefore as a consequence, the themes break from routine (BFR), interactive learning styles (ILS), increase pupil engagement (IPE), improve class attendance (ICA) and facilitate classroom activity (FCA) were included. This finding is in agreement with Chrysanthou’s (2008) findings that Geogebra mathematics software was strongly associated with changes and differences in the
organization and management of classroom environment. In this particular study, teachers and learners reported that the use of Geogebra software in teaching mathematics was a break from routine as well as a facilitator of productive classroom activity. The following is a discussion of the themes that emerged under the broad theme facilitation of effective classroom management for the current study.

4.4.1.1 Break From Routine (BFR)

The use of ICT in teaching mathematics was reported by the teachers as a break from normal school routine which may at times be quite boring. In most of the mathematics lessons that the researcher observed in various schools he visited, children were seen to be in high spirits and were enthusiastic. The mere fact that mathematics lessons were conducted in the computer laboratory rather than ordinary classrooms was seen as a break from routine. One teacher noted that routine at times could be quite boring making learning unattractive experience. The use of desktop computers, laptops and tablets in working out numeracy problems rather than using exercise books was seen by learners as a break from normal routine. This finding implies that at times breaking from normal classroom routine was a catalyst for effective learning. This finding is consistent with findings from previous research by Chrysanthou (2008) in which teachers and students attributed use of ICT in teaching mathematics as a break from normal boring classroom routine. This break from normal classroom routine contributed immensely in making the mathematics lessons more interesting, attractive, and enjoyable to learners (Chrysanthou, 2008). The students found the use of computer laboratories for learning mathematics rather than the ordinary classrooms as a break from their normal routine. Learning mathematics with ICT tools was a time that students always longed for.
4.4.1.2 Interactive Learning Styles (ILS)

The use of ICT in the teaching of numeracy concepts was found to be associated with increased interactions in the learning process. “Children are always incredibly active in class whenever ICT tools are used to teach mathematics,” reported one of the teachers interviewed. Most of the teachers interviewed reported that ICT tools facilitated interactive learning environment during mathematics lessons. They noted that children were rather more active in the classroom whenever they used ICT tools in the computer laboratory than when they did it in the dearth of ICT tools in their ordinary classrooms. One of the teachers was asked to explain how ICT facilitated interactions during mathematics learning sessions. In responding to this, below is an excerpt of what the teacher had to say:

“Every child in my class gets an opportunity to use a laptop or tablet. They (children) normally consult one another. They always help one another. Whenever we are in the lab, no child is ever seen idle and learning mathematics is always fun. Infact with ICT tools, children can learn without the teachers. They are always engaged in something constructive. You know for example, they take pictures, play games and compete with one another.”
[teacher in 5th interview]

In one of the mathematics lessons observed, the researcher noted that pupils worked collaboratively on their tablets as they learnt basic mathematics concepts such as simple addition. The children worked independently on their gadgets while at the same they consulted and shared ideas with each other. The researcher recorded a conversation between three pupils who were working on their tablets to perform an addition operation of whole numbers as captured in the following transcription (the names used are pseudonames for the sake of protecting the children’s identity):
Pauline: (To a pupil seated next to her) Use cows instead of hands. Cows look good. Look at mine. (the researcher moves next to Pauline to see what she was doing).

Philip: Ok. Let me see. (he fidgets with his tablet to change image settings from hands to cows). Oh, Look my cows are yellow while yours are green. I have never seen green cows. (he attempts to perform addition and gets excited about results displayed on his screen).

The teacher explained to the researcher that the programme was designed as a self-learning mathematics programme. It uses multimedia features of sound and images to demonstrate addition operation. A child was heard nearby trying to explain to another child on how to perform an addition operation. The following is an excerpt of a conversation between the two children:

Sinclair: (To another pupil seated next to her) Touch here.

Natalia: (Attempts to touch on the screen of her tablet using index finger but it doesn’t respond) Nothing is happening! (she exclaims)

Sinclair: (Picking up the tablet) Let me show you. (She touches on the screen lightly with her thumb and it responds) This is how it’s done (makes a hand gesture).

Natalia Give me I try. (She attempts and it responds)

The mathematics programme used in this class produced symbols, images and sounds simultaneously as children worked through addition of whole numbers. The programme began by a female voice defining addition as ‘putting together’. When a child touched a number on the screen of the tablet (for example number three), the number was displayed on the screen in figures (that is 3), at the same time three cows (or any object that the child had previously selected) came on the screen as a female voice called out the number. When the child touched the addition sign (+), a voice was heard in the
background saying, “put together.” Again when the child touched another number (for example two), its symbol was displayed on the screen (i.e. 2), and a corresponding number of objects (in this case two cows) were produced together with voice called out the number in the background. Finally, when the child touched the equal sign (=), the answer was produced in terms of a voice calling out the answer (that is 5), while at the same time a figure was displayed on the screen and images of five cows (or any object of choice according to a child’s preference) corresponding to the answer appeared. This finding is consistent with findings of previous studies which found that ICT facilitated interactive and collaborative learning. Chambers (2011) found that the use of web 2.0 based ICT tools such as forums, blogs and podcasts enabled primary school children to work mutually together. BECTA (2003) asserts that ICT facilitates improved group work and co-operative skills among learners.

4.4.1.3 Increase Pupil Engagement (IPE)

Use of ICT tools in teaching numeracy concepts was also found to be associated with increase of the level of pupils’ engagement in learning activities. Most of the teachers interviewed in this study reported that whenever children were allowed to use computers to learn numeracy concepts, they always became much more absorbed in the learning activities. One of the teachers interviewed reported as follows:

“"They (children) never get tired of learning numeracy skills whenever they are allowed to use computers. They are not even willing to take a break as long as they are working on computers. Whenever they do mathematics in their classrooms, they are always eager to go out for break. But interestingly, whenever they are in the computer lab, they get so engrossed with computers that they are willing to forego even their break just to continue doing mathematics using computers. Nothing motivates them to learn mathematics better than computers do. ” [teacher in 4th Interview]
This phenomena of increased engagement in learning activities could be attributed to the capacity of ICT tools in enabling children to work on mathematics solutions at their own pace. Most of the teachers overwhelmingly endorsed the argument that ICT tools facilitate learning of numeracy concepts at the learners’ own pace. Almost all the teachers interviewed in this study asserted that mathematics software installed in the desktop computers, laptops and tablets were mainly meant to facilitate independent learning at the learners’ own pace. This is what one of the teachers reported:

“The mathematics software installed in the computers was designed as a self-learning programme. The child follows instructions given and is able to get immediate feedback. This programme is also self-correcting. The child may not need the teacher to work through a problem. A child can make attempts at an assignment given and after several trials the system supplies the child with the correct answer. It is also able to reward the learner accordingly. For example if the learner gets an answer correct, it says “correct answer, very good or wrong answer, try again.”” [teacher in 1st interview]

This finding is in agreement with Chrisanthou’s (2008) finding that Geogebra mathematics software enabled students to work out mathematics problems at their own pace without holding or waiting for others. NCTM (2000) also argues that ICT has the ability to transform abstract mathematics concepts into concrete and visual representations that are easy for children to understand. NCTM further argues that ICT fosters children’s engagement with basic mathematics concepts by making them real and enjoyable.

4.4.1.4 Improve Class Attendance (ICA)

The teachers interviewed in this study overwhelmingly endorsed the argument that the use of ICT in the classroom increased class attendance. In fact it was observed that in cases ICT increased class attendance by a hundred percent (100%). According to the
findings of this study, ICT substantially helped to reduce instances of truancy and absenteeism among the pupils. Teachers reported that there was always extraordinary excitement among children on the prospect of using ICT in learning. It was reported that whenever they expected to use the ICT in learning, their class attendance improved. The following is an excerpt of what one of the teachers had to say:

“The use of desktop computers and laptops in learning mathematics takes place in the computer laboratory. There is only one computer lab in the school and therefore a programme has been put in place to control its use. Each class in the school is allowed to use the computer lab once per week. My class is normally scheduled to use the computer lab on every Wednesday. On that day I can assure you, we always have almost 100% attendance.” [teacher in 7th interview]

This finding is consistent with BECTA (2003) finding that ICT leads to improved attendance at school. BECTA further argues that ICT sparks students’ appetite for learning and at the same increases their enjoyment and commitment to learning. Children who enjoy and are committed to learning are more likely to attend class regularly as compared to their counterparts who may not be committed to learning.

4.4.1.5 Facilitate Classroom Activity (FCA)

The findings of this study revealed that ICT was useful in facilitating effectual learning activities during mathematics. Most of the teachers interviewed particularly from public primary schools indicated that ICT tools helped in regulating classroom activities. They reported that the teachers’ digital devices (laptops) and learners’ digital devices (tablets) came preloaded with two systems that helped manage learning activities during mathematics lessons. One of the systems was referred to as net support system while the other one was content hub. According to the teachers, the net support system helped the teacher to develop lesson plans, manage learning activities on children’s tablets, monitor
learning activities, send assignments to children on their tablets, collect assignments done by the pupils, mark the assignments and finally give feedback to the learners. The following is a transcription of what one of the teachers said about the use of net support system:

“First, net support system helps me develop a lesson plan, either by using word or power point program. Look here.” She shows the researcher a lesson that had been developed earlier on a power point program on her laptop. “I can present this lesson to the whole class using a projector or can just send it directly to the individual learners through their tablets. Second, it helps me to send learning content to the learners through their tablets. But it only sends to those children whose tablets are activated on the system. When the system is turned on, it automatically detects all active tablets in class, then prompts learners to register by typing their names in a dialogue box. Look here.” She shows the researcher the pupils already registered on the system. “The system enables the teacher to send learners tasks and assignments on their tablets. It also helps the teacher to modify existing content to suit learners needs.” [teacher in 6th interview]

On responding to the question about how the net support system helps to manage and control the class, here is what the teacher had to say:

“I normally use the system to either blank the tablets or lock them out. When I blank the tablets out, their screens darken so that the learners can’t use them anymore. And when I lock the tablets out, their touch screens immediately become inactive. When I blank or lock out the tablets, the learners become attentive to me as they try to seek my attention and help. Sometimes the children become so engrossed on the tablets that they do not pay attention to me at all. Other times they deviate from the expected learning activities. Therefore blanking or locking out their tablets helps me to attract their attention back.” [teacher in 6th interview]

So according to the teachers interviewed, ICT devices can be used to manage class activities and give teachers command on class control. Oldknow and Taylor (2000) assert
that ICT motivates, encourages and stimulates learners during mathematics lessons. BECTA (2003) argues that use of ICT in teaching leads to increased motivation and commitment to learning tasks in literacy and numeracy.

### 4.4.2 Influence of ICT on Cognitive Amplification

Six themes emerged under the broad theme cognitive amplification through data coding process. Most of the teachers interviewed reported that ICT enhanced the learning of numeracy concepts by amplifying pupil’s cognitive abilities. Through axial coding process, the following themes emerged under the broad theme cognitive amplification: Reduced pupil weakness (RPW), mathematics becomes attractive (MBA), raised pupil attention (RPA), increased pupil concentration (IPC), promoted learner autonomy (PLA), improved Pupil’s memory (IPM).

#### 4.4.2.1 Reduce Pupil Weakness (RPW)

The teachers who were interviewed reported that ICT provided a lot of opportunities for children with lower abilities in learning mathematics to actively participate in numeracy activities. One of the teachers interviewed reported that computers enabled all learners to actively participate in numeracy activities regardless of their ability levels in mathematics. Here is what the teacher had to say:

> “Computers provide opportunities for all the children to work out mathematics problems at their own pace. Mathematics concepts are simplified through animated objects and games. Mathematics has become much simpler even to children who had viewed it initially as difficult and unachievable.” [teacher in 3rd interview]

This finding is in agreement with Chrysanthou (2008) who found that Geogebra mathematics software was able to extenuate students’ weakness in learning mathematics.
The program provided opportunities for students with low learning abilities to be able to actively engage in learning mathematics. Furthermore, BECTA (2003) found that ICT leads to enhanced sense of achievement among students especially those who had previously been under-achieving in class. According to Becta (2003) ICT creates a culture of success among learners by stimulating interest in mathematics learning activities.

4.4.2.2 Mathematics Becomes Attractive (MBA)

According to this theme, learning numeracy concepts with the use of ICT makes it a pleasant and attractive activity. In the third mathematics lesson the researcher observed, children were seen excitedly tapping on their tablets, they were deeply enthralled with the on going mathematics activities. Children were seen sharing experiences and information on their tablets. In fact most of the teachers interviewed reported that ICT stimulated the learners interest in basic mathematics concepts and their concentration on numeracy activities was noticeably more than usual. In one of the lessons the researcher observed, children seemed reluctant to break for lunch. Their teacher reported as follows:

“Use of computers for teaching and learning purposes has made numeracy activities more attractive than ever. Infact we literally force children to get out of the computer laboratory to go for tea break, lunch break and games.” [teacher in 6th interview]

One of the teachers interviewed reported that ICT tools have inbuilt multimedia features which are responsible for the children’s increased interest in numeracy activities. The following is an excerpt of what the teacher had to say:

“The computers enable children to learn numeracy skills through text, animated images and thrilling sound effects. They (computers) enable children learn mathematics with so much fun.” [teacher in 4th interview].
This finding is consistent with Chrysanthou’s (2008) finding that ICT makes learning more attractive and enjoyable. The study found that Geogebra software contributed in making numeracy concepts more appealing and enjoyable to students. BECTA (2003) argues that ICT stimulates and sparks students appetite in learning and creating a culture of success among learners. BECTA further notes that ICT leads to enhanced enjoyment in learning tasks and an increased sense of achievement.

4.4.2.3 Raise Pupil Attention (RPA)

According to the study findings, ICT contributes immensely in raising pupils’ attention during numeracy activities. Most of the teachers interviewed reported that children paid more attention during numeracy activities whenever ICT tools were used for learning. The teachers reported that there was a great difference in the children’s attention during mathematics lesson conducted in the computer laboratory than in their ordinary classrooms. One of the teachers interviewed reported that she always witnessed unusual increase in pupil attention during numeracy activities particularly when ICT tools were used. Here is an excerpt of what the teacher had to say:

“Computers enable children to learn numeracy skills through games and animated images. This makes learning of mathematics fun and interesting resulting in increased attention in class.” [teacher in 3rd interview]

The 4th teacher to be interviewed added that ICT devices make children to enjoy learning mathematics thus increasing their attention in their learning of numeracy concepts. The teacher reported as follows:

“Through tablets, children find mathematics learning session an enjoyable experience. Since the inception of tablets in the teaching of numeracy
concepts, children are always looking forward to learning mathematics.”
[teacher in 4th interview]

Chrysanthou (2008) found that Geogebra mathematics software stimulated children’s attention in the classroom. The software enabled the students to focus their attention on learning mathematics concepts and procedures while at the same time freeing them from engaging in subordinate tasks.

4.4.2.4 Increase Pupil Concentration (IPC)

Nearly all the teachers who were interviewed in this study overwhelmingly reported that ICT increased children’s concentration on the learning of numeracy tasks at hand. The teachers indicated that children’s level of concentration in numeracy activities always increased whenever ICT tools were used in teaching numeracy concepts. The 5th teacher to be interviewed in this study reported that whenever she used computers to teach numeracy concepts, noise making and learning disruptions among pupils were noticeably non existent. According to the teacher noise making and learning disruptions were a common trend in an ordinary mathematics class. Here is excerpt of what the teacher noted:

“Whenever I use computers to teach numeracy skills, my work is always very easy. There is no shouting, keep quiet! Children simply settle down right away for learning and concentrate on tasks at hand. Nothing else captures their (children) interest better than computers do.” [teacher in 5th interview]

It was also noted that ICT increases the the children concentrate on a task. The 2nd teacher to be interviewed in this study reported that children in her mathematics class were able to concentrate on mathematics activities for a long time. Here is a transcription of what she reported:
“Computers encourage children to discover concepts by themselves even without the help of the teacher. Children are able to concentrate on their gadgets for a long time without ever getting tired of them (computers). With computers, these children don’t seem to ever get tired. The level of concentration is normally high whenever they are allowed to work out math problems using computers.” [teacher in 2nd interview]

In addition, the 7th teacher to be interviewed noted that ICT brings joy and excitement in children consequently increasing their level of concentration in learning. The teacher reported as follows:

“Children normally get so excited whenever they are allowed to use computers to learn numeracy skills. This increases their level of concentration in learning basic mathematics concepts.” [teacher in 7th interview]

This finding is in agreement with BECTA’s (2003) argument that ICT can stimulate, motivate and spark students’ appetite for learning as well as creating a culture of success. Furthermore, use of ICT in the classroom leads to increased commitment to learning task by pupils, enhanced enjoyment, interest and sense of achievement in learning (BECTA, 2003).

4.4.2.5 Promote Learner Autonomy (PLA)

The argument that ICT promotes learner autonomy during mathematics learning activities emerged very strong in this study. Nearly all the teachers interviewed reported that ICT promoted self-learning among children. The 1st teacher to be interviewed asserted that under normal circumstances, children relied heavily on their teachers’ guidance to solve numeracy problems. Here is a excerpts of what she reported:

“With ICT children learn and work out mathematics problems by themselves. The program we have enables children to learn mathematics concepts through play. In every topic children are given instructions on
how solve math problems through audio-visual aids. Then they are asked to take an assignment in which they attempt to solve similar problems. If a child is unable to get it right, the program prompts him/her to try again. After several attempts the program supplies the required answer. So it allows children to learn mathematics on their own. The teacher’s role is reduced to a supervisory one.” [teacher in 1st interview]

It was also reported that ICT provides learners with easy simple-to-follow instructions given through multimedia. Therefore learners are able to follow these simple instructions easily and solve basic mathematics problems by themselves. The 4th teacher to be interviewed reported as follows:

“The math program installed in the computers was designed for self-learning. The program gives learners easy and simple to follow age-appropriate mathematics instructions.” [teacher in 4th interview]

The researcher observed children work out numeracy problems on their ICT devices with little or no intervention at all from the teacher. Little children were observed tapping on their tablets confidently as they solved mathematics problems. In one of the lessons that the researcher observed during the study, a child sitting next to the researcher was seen attempting to do addition of whole numbers on his tablet. He was seen pressing number three (3) on the tablet, as a voice called out ‘three’ in the background while at the same time three images of cows appeared on the screen. The child then pressed the symbols plus (+) and two (2). A voice in the background called out plus two as two images of cows appeared on the screen. The boy then pressed the equal sign (=) on the tablet and a symbol for number five (5) together with five cows appeared on the screen. A voice called out in the background that, “the answer is five.” One of the teachers interviewed reported that ICT motivated children to learn mathematics and therefore they did not
require the presence of the teacher in order to learn. Here is an excerpt of what the teacher reported:

“Whenever I ask children to go into the computer laboratory to learn numeracy skills, they normally get so excited that they don’t seem to require any other enticement to learn mathematics.” [teacher in 2nd interview]

This finding agrees with BECTA (2003) assertion that ICT has positive effects on students’ enjoyment and interest in learning. This goes a long way in increasing the learners’ motivation, independence and self-directed study. Chrysanthou (2008) associated Geogebra mathematics software with promotion of pupil autonomy by asserting control on their own learning without the constant need of the teacher. However, NCTM (2000) argues that successful use of ICT in teaching mathematics depends on teachers because ICT is not a panacea parse. Teachers play a key role in selecting and creating mathematics tasks that take advantage of ICT to be effectively learnt.

4.4.2.6 Improve Pupil’s Memory (IPM)

It was overwhelmingly reported that ICT enabled children to easily remember numeracy concepts previously learnt. One of the teachers interviewed reported as follows:

“They (children) never forget what they learn in the computer lab. They always remember everything they learnt previously using the tablets. Surprisingly, they normally find it difficult remember some of the things they learn in their normal classroom without ICT.” [teacher in 6th interview]

Most of the teachers interviewed reported that the multimedia features embedded in ICT devices enabled children to learn mathematics concepts in a relaxed atmosphere and
therefore they were able to retain most of the numeracy concepts learnt. Here is an excerpt of what one teacher reported:

“Computers have multimedia features that allow children to learn mathematics through images, sound, motion and real life experiences. It is very difficult for children to forget what they learn through such a stimulating environment.”
[teacher in 3rd interview]

4.5 Teachers’ Professional Development Status and their Use of ICT in Teaching

Mathematics
The third objective of this study sought to determine whether teachers’ training on ICT influence their use of ICT in teaching numeracy concepts. To gain insights into this objective, the researcher collected quantitative data from 109 teachers from 37 lower primary schools and subsequently interviewed 7 teachers who had indicated that they used ICT to teach numeracy concepts. Data was gathered on the kind of training the teachers had been given. Data was also captured on the kind of ICT knowledge and skills that teachers possessed. Therefore two sets of data were collected: First was on teachers’ training on basic ICT skills and second was on teachers’ Technological, Pedagogical and Content Knowledge (TPACK)

4.5.1 Teachers’ Training on Basic ICT Skills

To gather information on the kind of ICT training the teachers had undergone, the researcher asked the following questions: Have you undergone any form of ICT training before? If yes, where did you get trained?

Table 4.16 presents the findings of the study on teachers’ ICT training.
Table 4.16: Descriptive Statistics on Teachers’ ICT Training

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trained</td>
<td>100</td>
<td>91.7%</td>
</tr>
<tr>
<td>Not trained</td>
<td>9</td>
<td>8.3%</td>
</tr>
<tr>
<td>Total</td>
<td>109</td>
<td>100%</td>
</tr>
</tbody>
</table>

The findings of the study as shown on table 4.16 indicated that nearly all the teachers had undergone some form of ICT training. Approximately 92% of the teachers indicated that they had undergone a training on ICT skills. An insignificant number of the teachers indicated that they never received any formal training on ICT skills. The researcher further sought to establish institutions where the teachers had received their training on ICT skills. Table 4.17 shows the study findings on places where the teachers had received their training on ICT skills.

Table 4.17: Descriptive Statistics on Places Teachers Received ICT Training

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seminar/workshops</td>
<td>43</td>
<td>39.4%</td>
</tr>
<tr>
<td>Commercial college</td>
<td>28</td>
<td>25.6%</td>
</tr>
<tr>
<td>TTC/University</td>
<td>16</td>
<td>14.7%</td>
</tr>
<tr>
<td>TTC/Seminar/Commercial</td>
<td>13</td>
<td>12.0%</td>
</tr>
<tr>
<td>None</td>
<td>9</td>
<td>8.3%</td>
</tr>
<tr>
<td>Total</td>
<td>109</td>
<td>100%</td>
</tr>
</tbody>
</table>

The findings on table 4.17 indicates that majority of the teachers had received their training through seminars and workshops. Post-questionnaire teacher interviews revealed
that the ICT workshops and seminars had largely been organized by the Government of Kenya through the Ministry of Education and a local NGO. The increase in number of teachers trained on ICT skills through workshops and seminars could be attributed to the rigorous training programme for the implementation of the National Digital Literacy Program in public primary schools. One of the teachers who was interviewed reported that the Government of Kenya had embarked on training two teachers from each public primary school. Here is an excerpt of the teacher said:

“I got trained in a seminar at Sparki Primary School that was organized by the government. We were trained on how to use a computer to teach mathematics, science and English. We were also trained on basic computer skills as well proper use and maintenance of computers. This training targeted two teachers teaching in lower primary from every public school in the area.” [teacher in 1st interview]

The findings of the study as shown on table 4.17 indicate that a quarter of the teachers had received their ICT training from commercial computer colleges. Most of the teachers who had received their training from commercial computer colleges mainly hailed from private schools. A teacher from one private primary school reported that she had received her training on ICT skills from a commercial computer college in a nearby urban centre. Here is what the teacher had to say:

“I received my training from a commercial computer college in Kisauni. The training covered computer packages such MS Word, Excel, Access, Powerpoint, Publisher and graphics. I enrolled in this college through self initiative to gain computer skills for my personal use.” [teacher in 2nd interview].

The study also found that about a quarter of the teachers who participated in the study received training on ICT skills from either a teacher training college and university. Some
teachers indicated that they had at least undergone ICT training in all the institutions mentioned above. This implies that they had first enrolled in a teacher training college for a certificate or diploma course then proceeded to the university for a degree. Later on they attended seminars and workshops on ICT organized by their schools and finally enrolled in a commercial computer college for further training on ICT skills. This finding implies that some teacher training colleges and universities had revised their curriculum to include ICT in the training. The study findings indicate that a paltry 8% of the teachers had no formal training on ICT skills. This finding is consistent with Mogire (2013) who found that majority of secondary school teachers in Kisii had trained in basic computer literacy skills. The study found that 91% of the teachers had computer literacy skills. The study however found that although most teachers were trained on ICT skills, they lacked the necessary skills useful in the integration of ICT in teaching. According to Hermans et al (2008) teachers need support to gain deeper knowledge in their use of ICT to enhance learning. Krug and Arntzen (2010) argue that effective use of ICT in teaching does not just include adding ICT skills into existing pedagogical classroom practice but requires sustained and progressive professional development of teachers. Therefore, teachers do not only need to be imparted with basic ICT skills but need to be supported in attaining technological, pedagogical and content competence in order to effectively integrate ICT in their teaching of mathematics.

4.5.2 Technological, Pedagogical and Content Knowledge

The study also sought to establish whether the teachers possessed Technological, Pedagogical and Content Knowledge (TPACK) that was deemed necessary for effective and successful integration of ICT for teaching and learning purposes. Literature reviewed
revealed that mere possession of basic ICT skills was not enough for effective use of ICT in teaching numeracy concepts. To collect data on TPACK knowledge, the respondents were asked to select an option that best described their knowledge.

They responded to nine items measuring TPACK knowledge on a five-point likert scale ranging from no competence, little competence, not sure, more competence and much competence. The scoring of this scale was as follows: No competence=1, Little competence=2, Not sure=3, More competence=4, and Much competence=5. Table 4.18 shows the results of the study.

**Table 4.18: Descriptive Statistics on Teachers’ TPACK Knowledge**

<table>
<thead>
<tr>
<th>Statement: I can use ICT facilities to:</th>
<th>Level of Competence</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can use ICT facilities to:</td>
<td></td>
</tr>
<tr>
<td>Upgrade instructional materials</td>
<td>None 63.3% Little 17.4% Not Sure 0% More 14.7% Much 4.6%</td>
</tr>
<tr>
<td>Determine math needs of learners</td>
<td>None 73.4% Little 12.8% Not Sure 0.9% More 10.1% Much 2.8%</td>
</tr>
<tr>
<td>Develop appropriate math activities</td>
<td>None 68.8% Little 15.6% Not Sure 0% More 12.8% Much 2.8%</td>
</tr>
<tr>
<td>Implement effective class management</td>
<td>None 67.9% Little 14.7% Not Sure 0.9% More 14.7% Much 1.8%</td>
</tr>
<tr>
<td>Engage effective pedagogical practice</td>
<td>None 62.4% Little 19.3% Not Sure 0% More 15.6% Much 2.8%</td>
</tr>
<tr>
<td>Develop effective math assessment</td>
<td>None 67.9% Little 23.9% Not Sure 0% More 6.4% Much 1.8%</td>
</tr>
<tr>
<td>Update mathematics knowledge</td>
<td>None 50.5% Little 13.8% Not Sure 0.9% More 28.4% Much 6.4%</td>
</tr>
<tr>
<td>Update ICT knowledge and skills</td>
<td>None 61.5% Little 15.6% Not Sure 0.9% More 16.5% Much 5.5%</td>
</tr>
<tr>
<td>Engage social media such as facebook, whatsapp to enhance math learning</td>
<td>None 71.6% Little 18.3% Not Sure 0.9% More 3.7% Much 5.5%</td>
</tr>
<tr>
<td>Prepare suitable lesson plan</td>
<td>None 53.2% Little 11.0% Not Sure 0% More 27.5% Much 8.3%</td>
</tr>
<tr>
<td>Mean Score</td>
<td>64.05 16.24 0.9 13.76 4.23</td>
</tr>
</tbody>
</table>
Majority of teachers indicated that they were unable to integrate ICT in their teaching of numeracy concepts despite most of them having been trained on ICT skills. The study findings as shown on table 4.18 indicate that nearly three quarters of the teachers did not possess Technological, Pedagogical and Content knowledge. The findings indicate that nearly 60% of the teachers had no competence at all on all the ten items of TPACK. The study results further indicate that more than two thirds of the teachers indicated that they had no knowledge of using available ICTs to update their mathematics instructional materials. Only a third of the teachers had the necessary competence to use ICTs to update their mathematics instructional materials.

According to the study findings, more than two thirds of the teachers sampled had no competence at all in the use of ICT tools in developing appropriate numeracy learning activities. Only approximately a third of the teachers indicated that they were competent enough to use ICT in developing numeracy learning activities. However, quite a number of teachers indicated that they were competent enough to update their mathematics knowledge as well as develop lesson plans using ICT tools.

Furthermore according to the study findings, nearly half of the teachers indicated that they were competent in using ICT resources in updating their mathematics knowledge. Likewise, approximately a half of the teachers who participated in the study indicated that they were competent in using ICT to develop mathematics lesson plans. This assertion could be attributed to the fact that updating mathematics knowledge and developing lesson plans using ICT did not require specialized ICT skills. Basic skills in ICT use could have been sufficient for a teacher to surf the internet and download
teaching materials. Similarly, development of a lesson plan using ICT tools might have just required basic understanding of Word or Power-point program on a computer.

Generally, the study found that the teachers were low on the Technological Pedagogical and Content Knowledge (TPACK). Literature shows that TPACK is a pre-requisite for effective use of ICT for teaching-learning purposes. The study findings as shown on table 4.20 indicated that more than two thirds of the teachers (64%) had no competence in all the items of TPACK knowledge. Only about a third (34%) indicated they were at least competent on TPACK knowledge items. A half of these teachers had little competence, while another half were much more competent. One teacher was not sure of his/her level of confidence on TPACK knowledge. Table 4.19 shows the computed mean scores for the TPACK knowledge items of the Teacher Questionnaire.
Table 4.19: Descriptive Statistics on Means for TPACK Knowledge

<table>
<thead>
<tr>
<th>Statement on TPACK Knowledge</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Upgrade instructional materials</td>
<td>1.80</td>
<td>1.27</td>
</tr>
<tr>
<td>2 Determine math needs of learners</td>
<td>1.56</td>
<td>1.10</td>
</tr>
<tr>
<td>3 Develop appropriate numeracy activities</td>
<td>1.65</td>
<td>1.16</td>
</tr>
<tr>
<td>4 Implement effective class management</td>
<td>1.68</td>
<td>1.16</td>
</tr>
<tr>
<td>5 Engage effective pedagogical practice</td>
<td>1.77</td>
<td>1.21</td>
</tr>
<tr>
<td>6 Develop effective numeracy skills assessment</td>
<td>1.50</td>
<td>0.93</td>
</tr>
<tr>
<td>7 Update mathematics knowledge</td>
<td>2.27</td>
<td>1.48</td>
</tr>
<tr>
<td>8 Update ICT knowledge and skills</td>
<td>1.89</td>
<td>1.34</td>
</tr>
<tr>
<td>9 Engage social media e.g. facebook</td>
<td>1.53</td>
<td>1.08</td>
</tr>
<tr>
<td>10 Prepare schemes of work and lesson plan</td>
<td>2.18</td>
<td>1.50</td>
</tr>
<tr>
<td><strong>Aggregate Mean</strong></td>
<td><strong>1.78</strong></td>
<td><strong>1.22</strong></td>
</tr>
</tbody>
</table>

The results of the study as shown on table 4.19 revealed that the teachers scored lowly on a scale of TPACK knowledge. Most of the teachers scored nearly 2.0 on all ten items measuring TPACK knowledge. On average, the teachers scored 1.78 on all ten items of the TPACK knowledge which was rounded off to a score of 2.0 out of a scale of 5.0. This implies that the teachers generally had little competence on the measure of Technological, Pedagogical and Content Knowledge. This finding is in agreement with findings by AL Herbi (2014) who found that there was low level TPACK knowledge among Saudi High School teachers which resulted in low level ICT use in teaching mathematics. AL Herbi (2014) found that TPACK knowledge among the teachers was the main predictor variable for effective use of ICT for classroom instruction. Sandholtz and Reilly (2004) state that teachers ICT skills are strong determinants of ICT use in the
classroom instruction. They further argue that teacher training programmes should concentrate on equipping teachers on pedagogical use of ICT rather than just imparting them with technical issues of ICT.

4.5.3.0 Relationship Between ICT Training and its Use in Teaching Mathematics

To explore whether there was a relationship between ICT skills and teachers’ use of ICT tools in teaching mathematics, the researcher tested the following hypothesis using Pearson Product-Moment Correlation Coefficient (Pearson’s r) technique.

\( H_0: \text{There is no significant relationship between teachers’ training on ICT and their use of ICT devices in teaching numeracy concepts.} \)

To explore this relationship, the researcher tested hypothesis \( H_0 \) using Pearson’s r technique. First, the researcher correlated scores on teachers’ basic ICT skills against their use of ICT tools in the teaching of numeracy concepts. Then the researcher correlated scores on teachers’ TPACK scores against their use of ICT in teaching numeracy concepts.

4.5.3.1 Relationship Between Teachers’ ICT Knowledge and Use of ICT in Teaching Numeracy Concepts

To explore this relationship, data on teachers’ training on ICT and use of ICT devices was gathered through a self administered Teacher Questionnaire. On teachers’ basic ICT skills, the respondents were asked to indicate whether they had any training ICT skills. They responded by selecting either Yes or No. To collect data on use of ICT devices to teach numeracy concepts, the teachers were asked to respond to the following statement
in the Teacher Questionnaire: I use ICT (computers, laptops, projectors, tablets) during teaching and learning of numeracy concepts. They responded to this statement by ticking one of the following alternatives: Never, once per term, once per month, once per week and daily. The item was scored as follows: Never=1, Once per term=2, Once per month=3, Once per week=4, A few times per week=5, and Daily=6. Table 4.20 shows the results of Pearson Moment Correlation Coefficient test on relationship between teachers ICT training and their use of ICT in teaching numeracy concepts.

<table>
<thead>
<tr>
<th>ICT Training</th>
<th>ICT used to teach mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.121</td>
</tr>
<tr>
<td>N</td>
<td>109</td>
</tr>
<tr>
<td>ICT used to teach mathematics</td>
<td>ICT Training</td>
</tr>
<tr>
<td>ICT Training</td>
<td>Pearson Correlation</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.05 level (2-tailed).

The relationship between teachers’ training on basic ICT skills (as measured by a score on basic ICT skills on the TQ) and the use of ICT in teaching numeracy concepts (measured by a score on teachers’ use of ICT tools in teaching numeracy concepts on the TQ) was investigated using Pearson Moment Correlation Coefficient technique. Preliminary analysis was performed to ensure that no violation of the assumptions of normality, linearity and homoscedasticity was done. The results of the study as shown on
table 4.20 indicated that the correlation between teachers’ ICT training and their use of ICT devices in teaching numeracy concepts was not significant where \( r = -0.22 \) and \( p = 0.12 > 0.05 \). The p value 0.12 was found to be more than the critical value of 0.05. The null hypothesis was therefore accepted on the basis of this result. The study therefore found no significant correlation between teachers’ training on basic ICT skills and their use of ICT tools in teaching numeracy concepts. This finding suggested that there was no strong relationship between teachers training on basic ICT skills and their use of ICT tools in teaching numeracy concepts.

Coefficient of determination was further computed to get an idea of how much variance in use of ICT in teaching numeracy concepts was explained by training teachers on ICT skills. This was achieved by squaring \( r \) value and converting to percentage by multiplying by 100. In this study \( r = .22 \), therefore \( r^2 = .22 \times .22 = .0484 \). This result indicates that 4.8\% of variance in teachers’ use of ICT in teaching mathematics can be attributable to their training in basic ICT skills. There is no much overlap between the two variables. Therefore the relationship between basic ICT skills and use of ICT to teach numeracy concepts was found to be insignificant.

This finding is congruent with an earlier finding in this study which revealed that despite majority of the teachers (92\%) having been trained on basic ICT skills, most of them (83\%) did not use ICT devices in their teaching of mathematics (See table 4.7 and 4.18). It was found that only about a fifth of the teachers (17\%) actually used ICT tools in their teaching of mathematics. This finding is consistent with Kagocha (2013) who found that most teachers in Nyeri County only possessed basic computer literacy skills acquired
through personal initiatives. Consequently, majority of them did not use ICT in their classroom instruction because they did not possess relevant knowledge and skills required to effectively integrate ICT in their pedagogical practices. Therefore, Pelgrum (2001) argues that the success of any educational program depends largely on specialized knowledge and skills that the teachers possess. Mishra and Koehler (2006) described TPACK as the emergent and expertise knowledge that was necessary for teachers to acquire in order to effectively integrate ICT into their classroom practice.

4.5.3.2 Relationship between Teachers’ TPACK and their Use of ICT in Teaching Numeracy Concepts

To explore this relationship, data on teachers’ TPACK knowledge and their use of ICT tools in teaching numeracy concepts was gathered through the self administered Teacher Questionnaire. On teachers’ TPACK knowledge, they were asked to select an alternative that best described them on the statements given measuring TPACK scale. The teachers responded by selecting one of the following: No competence=1, Little competence=2, Not sure=3, More competence=4, and Much competence=5. The level of TPACK knowledge was measured on a five-point likert scale as indicated above. SPSS software was used to compute a total score for TPACK knowledge called Total TPACK score. Total TPACK score was correlated with scores from teachers’ use of ICT to teach mathematics using Pearson’s Moment Correlation Coefficient technique at .05 sig. level. The results of this test are displayed on table 4.21 below.
Table 4.21: Pearson Correlations between TPACK and Use of ICT in Teaching Mathematics

<table>
<thead>
<tr>
<th>ICT used to teach mathematics</th>
<th>ICT used to teach mathematics</th>
<th>Total TPACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>.864**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>109</td>
<td>109</td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>.864**</td>
<td>1</td>
</tr>
<tr>
<td>Total TPACK</td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>109</td>
<td>109</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.05 level (2-tailed).

Preliminary analysis was also performed to ensure that there was no violation of the assumptions of normality, linearity and homoscedasticity. The results of the study as shown on table 4.21 indicates that the correlation between teachers’ TPACK knowledge and their use of ICT in teaching numeracy concepts was significant where $r = 0.86$ and $p = 0.000 < 0.05$. The p value 0.00 was found to be less than the critical value of 0.05. The null hypothesis was therefore rejected on the basis of this result. The findings of the study indicates that there was a strong positive correlation between teachers’ TPACK knowledge and their use of ICT in teaching mathematics. This finding implies that higher scores on teachers’ TPACK knowledge may lead to increased use of ICT in teaching mathematics. The coefficient of determination was computed to determine the size effect of teachers’ TPACK knowledge on their use of ICT in teaching numeracy concepts. This was done by squaring the $r = 0.86$ to get percentage of variance; which was found to be 0.75. This suggests that teachers’ TPACK knowledge accounted for up to 75% variance.
in their use of ICT in teaching numeracy concepts. This finding suggests that the Kenyan Government and school managers could increase teachers’ use of ICT in their teaching by up 75% by training them on TPACK knowledge. According to Mishra and Koehler (2006) Technological, pedagogical and content knowledge (TPACK) is an emergent kind of knowledge that forms the basis of good use ICT in classroom instruction. Likewise, Marks (1990) asserts that TPACK is a class of knowledge that is central to the teachers’ use of ICT in the classroom.

According Mishra and Koehler (2006) good teaching does not just involve simply summing up ICT skills into traditional teaching techniques and approaches. But rather, it depends upon deep knowledge of how ICT can be used to access and manipulate mathematics concepts. It has been established in research literature that the mere availability of ICT tools in the classroom does not guarantee successful implementation and effective use of ICT in teaching (Koehler & Mishra, 2005; as cited in AL Harbi, 2014). It is essential for teachers therefore to possess relevant knowledge and skills in order to effectively integrate ICT into their classroom practice. TPACK was found to be the kind of knowledge that teachers required in order to effectively adopt and use ICT in their teaching (AL Harbi, 2014). According to AL Harbi (2014) TPACK represents the connection between three domains of knowledge: Knowledge of ICT (technological knowledge), knowledge of subject matter (mathematics concepts) and knowledge of processes and methods of teaching mathematics (pedagogical knowledge). Shin, Koehler, Mishra, Schmidt, Baran and Thompson (2009) as cited in AL Harbi (2014) assert that for teachers to effectively integrate ICT into their mathematics teaching, they must understand how ICT, mathematics pedagogy and mathematics content interact with one
another to generate effective teaching techniques with ICT tools. Tondeur et al (2015) found that teachers only began to integrate ICT into their classroom practice after undergoing through a professional development programme. Before the programme was initiated, there was no meaningful use of ICT in the classroom.

4.6 Support in the Use of ICT in Teaching Mathematics

The forth objective sought to determine the kind of support teachers received in their use of ICT in teaching numeracy concepts.

To achieve this objective, the teachers were asked to respond to four items of the teacher questionnaire on management and support in the use of ICT in teaching numeracy concepts. They were asked to indicate whether there was: a technician in the school; whether there was adequate technical support in the use of ICT in teaching; whether there was adequate maintenance of ICT facilities and finally whether there was adequate opportunities for professional development in the use of ICT in teaching numeracy concepts. The teachers responded by ticking one of the following alternatives provided: Clearly no, Mostly no, Not sure, Mostly yes, and Clearly yes. The results of the study are shown on table 4.22 below:
Table 4.22: Descriptive Statistics on Support Teachers Receive in the Use of ICT to Teach Mathematics

<table>
<thead>
<tr>
<th>Statement</th>
<th>Clearly No</th>
<th>Mostly No</th>
<th>Not Sure</th>
<th>Mostly Yes</th>
<th>Clearly Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is a technician in the school</td>
<td>486.8%</td>
<td>19.3%</td>
<td>13.8%</td>
<td>12.8%</td>
<td>7.3%</td>
</tr>
<tr>
<td>There is technical support in using ICT</td>
<td>44.0%</td>
<td>4.6%</td>
<td>14.7%</td>
<td>21.1%</td>
<td>15.6%</td>
</tr>
<tr>
<td>There is regular maintenance of ICTs</td>
<td>39.4%</td>
<td>4.6%</td>
<td>18.3%</td>
<td>19.3%</td>
<td>18.3%</td>
</tr>
<tr>
<td>There is adequate support for training</td>
<td>59.6%</td>
<td>6.4%</td>
<td>8.3%</td>
<td>18.3%</td>
<td>7.3%</td>
</tr>
</tbody>
</table>

The findings of the study as shown on table 4.22 indicate that majority of the schools did not have a standby technician. Only a fifth (20%) of the teachers indicated that there was a technician in the school. The study also found that approximately a third (37%) of the teachers received technical assistance from their respective schools in the use of ICT in teaching numeracy concepts. Furthermore, about a third (37%) of the teachers indicated that there was regular maintenance of the ICT tools. Finally, the study findings revealed that only a quarter of the teachers received support from their school in the course of their professional development. Three quarters of the teachers did not get any support from their schools in their quest for professional development in the use of ICT teaching.

4.6.1.0 The Relationship between Support and Teachers’ Use of ICT in Teaching Numeracy Concepts

To explore whether there is a relationship between supporting teachers in technical matters of ICT and professional development and their use of ICT in teaching numeracy concepts; the following hypothesis was tested using One Way ANOVA at .05 sig. level.
4.6.1.1 Technical Support

To explore this relationship, the researcher gathered data from teachers on whether they received technical support in their use of ICT tools in teaching numeracy concepts. Teachers were asked to respond to the following item of the TQ: There is adequate technical support for use of ICT in teaching and learning numeracy concepts. They responded by ticking one of the following alternatives: Clearly No=1, Mostly No=2, Not Sure=3, Mostly Yes=4, and Clearly Yes=5. One way ANOVA between groups was conducted to explore the influence of technical support to teachers (as measured by technical support scale on the TQ) on their use of ICT in teaching numeracy concepts (as was measured by a score on TQ on teachers’ use of ICT in teaching mathematics). Subjects were divided into three groups: those who received technical support in use of ICT, those who did not receive ICT support and those who were not sure. The results of the ANOVA test are presented on table 4.23 below:

Table 4.23: ANOVA Computations on Differences in Use of ICT Between Teachers With and Without Support

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>37.262</td>
<td>4</td>
<td>9.315</td>
<td>4.224</td>
<td>.003</td>
</tr>
<tr>
<td>Within Groups</td>
<td>229.344</td>
<td>104</td>
<td>2.205</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>266.606</td>
<td>108</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The mean differences are significant at the 0.05 level
Table 4.23 indicates that the calculated value \( p = 0.003 < 0.05 \) with a calculated \( F = 4.22 \) at 4 df (degrees of freedom). This result shows that the \( p \) value of 0.003 was less than the critical value of 0.05. Therefore the difference in means was found to be significant and the null hypothesis was thus rejected. This finding implies that there was a significant difference in means in the use of ICT in teaching mathematics between teachers who received technical support and those who did not. This finding therefore suggested that technical support to teachers significantly influence their use of ICT in teaching numeracy concepts.

To determine the effect size of technical assistance on use of ICT in teaching numeracy concepts, eta squared was computed. Eta squared is calculated by dividing the sum of squares for between groups by the total sum of squares in the ANOVA table (Pallant, 2005). Table 4.23 indicates that sum of squares between groups is 37.262 and total sum of squares is 266.606. Therefore by dividing 37.262 by 266.606 results in 0.1398. This can be rounded off to .14. According to Cohen’s (1988) classification of effect size, .14 would be considered a large effect size. This could be interpreted to mean that 14% of variance in use of ICT in teaching numeracy concepts could be attributed to technical assistance teachers received in their use of ICT tools in their teaching.

Post-hoc multiple comparisons using Tukey HSD test was performed to establish which groups of teachers were significantly different in their use of ICT in teaching numeracy concepts. The results of the Post-hoc analysis test are presented on table 4.24 below:
Table 4.24: Post Hoc Comparisons on Teachers With and without Technical Support in the Use of ICT Using Tukey HSD Test

<table>
<thead>
<tr>
<th>(I) There is adequate technical support</th>
<th>(J) There is adequate technical support</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearly No</td>
<td>Not Sure</td>
<td>.458</td>
<td>.429</td>
<td>.822</td>
<td>-.73</td>
</tr>
<tr>
<td>Clearly Yes</td>
<td>Not Sure</td>
<td>-1.365*</td>
<td>.419</td>
<td>.013</td>
<td>-2.53</td>
</tr>
<tr>
<td>Clearly No</td>
<td>Clearly Yes</td>
<td>-1.824*</td>
<td>.517</td>
<td>.006</td>
<td>-3.26</td>
</tr>
<tr>
<td>Clearly Yes</td>
<td>Not Sure</td>
<td>1.365*</td>
<td>.419</td>
<td>.013</td>
<td>.20</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.

The results of the Post-hoc analysis as shown on table 4.24 reveal that groups of teachers who indicated ‘Clearly No’, Not Sure’ and ‘Clearly Yes’ differed significantly from each other in terms of their use of ICT in teaching mathematics. The result suggests that the group of teachers who indicated that they received technical support (Clearly Yes groups) differed significantly in their use of ICT in teaching mathematics with groups of teachers who did not receive technical support (Clearly No and Not Sure groups). This finding implies that technical assistance significantly influences teachers’ use of ICT in teaching numeracy concepts.

This finding is consistent with findings from a previous study by Wanjala et al. (2015) which found that there was a significant relationship between technical support and teachers’ use of computers in teaching mathematics. The findings from Wanjala et al
(2015) study revealed that most teachers do not possess sufficient expertise in computer use for instructional purposes. Tong and Trinidad (2005) argue that lack of technical support for teachers make them to become frustrated with ICT tools consequently resulting in their reluctance in use of ICT in their teaching. Becta (2004) argue that lack of technical support may result in lack of technical maintenance of ICT tools resulting in higher risks of technical failure of ICT tools during teaching and learning process. Therefore, Yilmaz (2011) asserts that beside equipping schools with ICT hardware, software and internet, it is necessary to provide teachers with technical support in the use of these tools in teaching.

4.6.1.2 Support on Teachers’ Professional Development

To explore this relationship, the researcher collected data from teachers on whether they received support in their professional development in the use of ICT tools in teaching. They were asked to respond on the following item of the TQ: There are adequate opportunities for professional support in the use of ICT in teaching. They responded by ticking one of the following alternatives: Clearly No=1, Mostly No=2, Not Sure=3, Mostly Yes=4, and Clearly Yes=5. Likewise, One way ANOVA between groups was conducted to explore the influence of the support teachers received in the course of their professional development (as measured by a scale on support to teachers’ professional development on the TQ) on their use of ICT in teaching mathematics (as was measured by a score on TQ on teachers’ use of ICT in teaching mathematics scale). Subjects were divided into two groups: those who received support in the course of their professional development in using ICT in teaching and those who did not receive that kind of support. The results of the ANOVA test are presented on table 4.25 below:
Table 4.25: ANOVA Computations on Differences in Use of ICT Between Teachers With and Without Support

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>131.561</td>
<td>4</td>
<td>32.890</td>
<td>36.44</td>
<td>.000</td>
</tr>
<tr>
<td>Within Groups</td>
<td>93.852</td>
<td>104</td>
<td>.902</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>225.413</td>
<td>108</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The mean differences are significant at the 0.05 level.

Table 4.25 indicates that the calculated value was $p = 0.00 < 0.05$ with a calculated $F = 36.45$ at 4 df (degrees of freedom). This results shows that $p$ value of 0.00 is less than the critical value of 0.05. The result also shows that the F statistic (36.4) is substantial, meaning there is more variance between and within groups. The difference in means for the three groups of teachers who received support in their PD (Clearly Yes) and those who did not receive support in their PD (Clearly No and Not Sure groups) were found to be significant. The null hypothesis was therefore rejected on the basis of this result.

To determine the effect size of supporting teachers’ professional development on their use of ICT in teaching mathematics, eta squared was computed. Table 4.25 shows that the sum of squares between groups was 131.561 and the total sum of squares was 225.413. Therefore, dividing 131.561 by 225.413 results in 0.5836; which can be rounded off to .58. According to Cohen (1988) .58 would be considered a large effect size. This result could be interpreted to mean that nearly 58% of the variance in the use of ICT in teaching mathematics could be attributable to the support teachers receive in pursuing professional development course in the use of ICT for pedagogical purposes.
Post-Hoc multiple comparisons using Tukey HSD test was performed to establish the groups of teachers which significantly differed in their use of ICT in teaching mathematics. The results of the Tukey HSD test are presented on table 4.26 below:

Table 4.26: Post Hoc Comparisons on Groups of Teachers With and Without PD Support in the Use of ICT in Teaching Mathematics Using Tukey HSD Test

<table>
<thead>
<tr>
<th></th>
<th>(J) There is adequate technical support</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I) There is adequate technical support</td>
<td>Clearly No</td>
<td>Not sure</td>
<td>-.688</td>
<td>.274</td>
<td>.097</td>
<td>-1.45</td>
<td>.07</td>
</tr>
<tr>
<td></td>
<td>Clearly yes</td>
<td>-3.158*</td>
<td>.268</td>
<td>.000</td>
<td>.000</td>
<td>-3.90</td>
<td>-2.41</td>
</tr>
<tr>
<td></td>
<td>Clearly no</td>
<td>.688</td>
<td>.274</td>
<td>.097</td>
<td>.000</td>
<td>-0.70</td>
<td>1.45</td>
</tr>
<tr>
<td></td>
<td>Clearly yes</td>
<td>-2.471*</td>
<td>.331</td>
<td>.000</td>
<td>.000</td>
<td>-3.39</td>
<td>-1.55</td>
</tr>
<tr>
<td></td>
<td>Clearly no</td>
<td>3.158*</td>
<td>.268</td>
<td>.000</td>
<td>.000</td>
<td>2.41</td>
<td>3.90</td>
</tr>
<tr>
<td></td>
<td>Clearly Yes</td>
<td>Not sure</td>
<td>2.471*</td>
<td>.331</td>
<td>.000</td>
<td>1.55</td>
<td>3.39</td>
</tr>
</tbody>
</table>

*. The mean difference is significant at the 0.05 level.

The results of the Tukey HSD Test as shown on table 4.26 reveal (as indicated with the asterisk *) that all the groups of teachers significantly differed in their on use of ICT in teaching mathematics. The result indicates that groups of teachers who indicated ‘Clearly No’ and Not Sure’ differed significantly with the group that indicated ‘Clearly Yes’ in their use of ICT in teaching mathematics. Therefore, teachers who were supported in their course of professional development in ICT differed significantly in the use of ICT in teaching mathematics with the groups of teachers not supported. This finding implies that supporting teachers in pursuing professional development course in ICT significantly influences their use of ICT in teaching mathematics.
This finding is consistent with findings from Franklin (2007) study that found that teachers’ professional development is a vital ingredient in the successful use of ICT in classroom instruction. This study revealed that teachers’ ICT-related training programmes developed and increased teachers’ competencies in ICT use in class. Likewise, professional development courses in ICT influences teachers’ attitudes towards use of ICT in teaching. It is therefore of great essence to support teachers in their pursuance of professional development courses in ICT use in teaching mathematics.

4.7.0 The Influence of ICT on Teachers’ Pedagogical Techniques in Teaching Mathematics

The fifth objective of the study sought to establish whether the use ICT tools in teaching numeracy concepts influenced their pedagogical practices.

To achieve this objective, the researcher gathered qualitative data through observation of mathematics lessons and post-observation teacher interviews in order gain insights into techniques employed by teachers in teaching mathematics using ICT tools. Data was analyzed qualitatively in order to identify orchestration techniques utilized by teachers in teaching mathematics using ICT tools. Four orchestration techniques were identified through theory-driven and data coding process. The four orchestration techniques included the following: Technical-demo, explain-the-screen, link-the-screen and discuss-the-screen techniques. The study found that the techno-demo orchestration technique was the most widely used by the teachers in teaching mathematics. This finding is consistent with the finding by Drijvers (2010) which identified six orchestration techniques used by teachers in the Netherlands. The six included the technical-demo, explain-the-screen,
link-the-screen, discuss-the-screen, spot-and-show, and Sherpa-at-work. Drijvers (2010) also found that technical-demo was the most commonly used teaching technique employed by teachers in their classroom instruction. The orchestration techniques identified in the present study are discussed as follows:

4.7.1 Technical-Demo Orchestration Technique

This technique involved the teacher demonstrating something or a mathematics problem to children by projecting it on a screen for all the children in class to see. According to Drijvers (2010) technical-demo orchestration is a demonstration-like teaching technique carried out in an ICT environment. This could be done by either projecting it on a large screen using an overhead projector or just simply demonstrating on the teacher’s computer screen. The latter involves inviting children to the teacher’s desk in order to observe what is happening on Teachers’ Digital Device (laptop). In almost all the lessons observed, the teachers demonstrated mathematics problems or tasks to children through the use of a projector. The teachers worked on their laptops and projected the content through a projector to a screen made of clothing material displayed in the computer laboratories. In one of the lessons the researcher observed, the teacher demonstrated the concept of shapes using technical-demo technique. The teacher projected shapes from her laptop using a projector to a fabric screen placed on a blackboard in the computer laboratory. In this technique, the teacher manipulated the shapes by varying sizes, angles and colours as children marveled. The researcher interviewed the teacher immediately after the lesson. Here is what the teacher had to say:

“I normally demonstrate how to solve a mathematics problem to children on my laptop and then use a projector to display them on a screen. Sometimes I
just show them how to do it on my laptop or I go round showing them on their laptops." [teacher in 3rd interview]

This finding corresponds with Drijvers (2010) argument that technical-demo orchestration techniques involves demonstrating to children something as they follow on the screen.

4.7.2 Explain-the-Screen Orchestration Technique

This orchestration technique involved the teacher explaining to the whole class a mathematics task that was displayed in an ICT screen. All the teachers interviewed in the post lesson-observation interview reported that one of their roles was explaining to the children about ICT techniques or content displayed on their computer screens. In one of the lessons the researcher observed, a teacher was seen explaining to a child on how to perform a sorting and grouping activity on her tablet. Here is an excerpt of the conversation between the teacher and child:

Teacher: What do you want to do?

Marylene: I want to sort and group these objects

Teacher: Click here. (Shows the child by hand signal). If you want to group the object by colour, you click here. (touches on the child’s tablet).

Marylene: And what about sorting by the type of object?

Teacher: You click here. (touching on pupil’s tablet). You select the objects to sort and group here. Then you simply drag similar objects together like this (demonstrates).
According to Drijvers (2010) in this orchestration technique, the teacher explains to the children what happens on the ICT screen. It is the same as explaining what is displayed on the board technique in the non-technological teaching settings.

### 4.7.3 Link-the-Screen Orchestration Technique

This orchestration technique involved utilizing both the ICT screen and the blackboard to enhance learning of numeracy concepts. It could involve emphasizing a mathematics concept learnt on an ICT screen as well as on a chalkboard. Most of the teachers interviewed in the present study reported that they used both the ICT devices as well as the chalkboard to enhance acquisition of basic mathematics concepts in children. Similarly, in most of the mathematics lessons observed, the teachers demonstrated mathematics tasks both on computers as well as on chalkboards. It was also observed that all the computer laboratories had a fabric-made screen for ICT use as well as a chalkboard for conventional use. One of the teachers interviewed reported that sometimes she used both a computer and chalkboard to explain a numeracy concept. Here is a transcription of what she said:

“First, I demonstrate to children how to solve a mathematics problem, for example addition on the chalkboard. Then I use a computer to emphasize the process. Through images and sounds produced by a computer, I simplify the procedure for children to easily understand. Computers make it easy for children to understand basic mathematics concepts. However the content covered is quite shallow, so I have to use the chalkboard and textbooks to go deeper.” [teacher in 1st interview]

This excerpt demonstrates the importance of linking learning that take place in an ICT setting and that which takes place in a chalkboard and textbook environment. According
to Drijvers (2010) link-the-screen orchestration helps the teacher to emphasis the relationship that exist between what happens in an ICT setting and how the same could be represented in an ordinary learning environment involving the use of paper and pencil, textbooks and chalkboard.

4.7.4 Discuss-the-Screen Orchestration Technique

Discuss-the-screen orchestration technique involved the children discussing what they observed on an ICT screen. In most of the lesson presentations, it was observed that children often discussed in groups or sometimes in pairs the contents displayed on their screens. In one of the lessons the researcher observed, the teacher displayed shapes on a screen using a projector. The teacher then asked the children to discuss the properties of the shapes they observed on the screen. In another lesson, the children were seated in pairs with each pair sharing a laptop. The children were asked to play a game on their laptops that involved a number doubling itself whenever it was pressed. There ensued an interactive session in class where children got engrossed in the discussion. The researcher was seated next to a pair of children. Here is an excerpt of their conversation during the discussion (names used are not their real names to protect their identity):

_{John: Click on number two and let see what happens next.}_

_{Jane: (Clicks on number two) Look at what we got, number four.}_

_{John: It has added another two to give us four. Let try another and see what happens.}_

_{Jane: Click on number three. What do you get?}_

_{John: Six. So doubling number three means adding another three to get six._
From this excerpt, it can be noted that a discussion held in an ICT environment is quite enriching. This is because the pair of children in transcription above was able to discover that doubling a number was same as repeated addition. According Drijvers (2010) access to pupils’ work, tasks, problems or teachers approach can serve as the point of departure in a discuss-the-screen orchestration technique. It emerged from the teacher interviews that out of the four commonly used orchestration techniques employed in teaching mathematics, technical-demo was the most widely used. All the teachers who were included in the post lesson-observation interview reported by way of description that they used technical-demo orchestration technique in teaching mathematics. This finding is consistent with a finding from a previous study by Drijvers (2010) which indicated that technical-demo orchestration was the most widely used technique in teaching of mathematics in an ICT-driven teaching and learning classroom settings.

4.8.0 Determinants of Use of ICT in the Teaching of Numeracy Concepts

The sixth objective of this study sought to establish determinants that encourage or hinder the use ICT in teaching numeracy concepts.

To achieve this objective the researcher collected both quantitative and qualititative data from the teachers. Quantitative data was gathered through the use of Teacher Questionnaire while qualitative data was gathered through teacher interviews. Information on teachers’ professional development and technical support was gathered quantitatively through the use of a questionnaire. More detailed information on factors encouraging or hindering use of ICT was collected qualitatively through a semi-
structured interview of seven teachers from seven different primary schools (both private and public). Eight factors emerged as key determinants of use and non-use of ICT in teaching numeracy concepts. These factors included the following: teacher training, electricity, computer laboratory, class size and technical assistance. They also included availability of mobile and portable ICT devices, administrative support and finally time support.

4.8.1 Teacher Training

To gather data on teachers’ training on ICT skills, the teachers were asked to indicate whether they had undertaken any ICT training. They responded by ticking either yes or no. The study found that although majority of the teachers (93%) had at least indicated that they had undergone some formal training on ICT skills, very few teachers (17%) actually used ICT devices available in their schools to teach mathematics. According to the study, approximately three quarters (76%) of the teachers had basic ICT skills yet they did not use available ICT devices to teach mathematics. As shown earlier, the study found no significant relationship between teachers’ training in basic ICT skills and use of ICT devices in teaching mathematics. However, the study found a strong relationship between teachers’ acquisition of Technological, Pedagogical and Content Knowledge (TPACK) and use of ICT devices in teaching mathematics. Therefore training teachers on pedagogical use of ICT was found to be more beneficial rather than merely equipping them with basic ICT skills. The findings of this study elsewhere indicated that supporting teachers in their professional development on integration of ICT in teaching-learning processes significantly influenced their use of ICT in teaching numeracy concepts.
The general lack of assistance in professional development of teachers in the integration of ICT into their classroom practice was found to be a major hindrance in the use of ICT in teaching mathematics. The teachers from public schools who were interviewed during the study reported that their successful integration of ICT in teaching mathematics was as a result of the Government of Kenya’s concerted effort in training them on pedagogical use of ICT through seminars and workshops. The teachers however noted that the training was not sufficient. Here is what one teacher reported:

“We have been trained on how to teach math, science and English by use of computers at Sparki Primary. The training has helped me a lot in my work but I can’t say it was enough. Although we were taught a lot of things on ICT use, but it was in a very short time. I suggest that more trainings should be organized on regular basis.” [teacher in 6th interview]

The above sentiment was also echoed by another teacher who reported that the training period was too short to be effective. She noted that the training period was too short to be helpful to the less experienced teachers in matters of ICT. The following is a transcription of what she reported:

“This training was too short to be helpful to teachers who had little if any background knowledge in ICT. The training was however much more helpful to teachers who had experience with ICT tools like myself.” [teacher in 7th interview]

It was also reported that some of the trainers did not possess adequate ICT knowledge and skills to conduct thorough and effective training for the teachers. One of the teachers interviewed reported that she was trained by a colleague who had already been trained in the same programme. Chao (2015) found that there was haphazard training in Mombasa
of teachers in pedagogical use of ICT in teaching due to lack of appropriate policy and standards.

This study therefore found professional development of teachers in pedagogical use of ICT in teaching mathematics as an important determinant in the integration of ICT in the teaching of mathematics. In nearly all the schools that embraced the use of ICT in teaching mathematics, the teachers reported that they underwent some kind of training on pedagogical use of ICT in teaching. Furthermore, all the three teachers who hailed from the public primary schools indicated that they had attended a seminar organized by the Government of Kenya on integration of ICT in teaching. The researcher asked teachers to indicate whether they had been trained on the use of ICT in teaching mathematics and who sponsored the training. In responding to this, here is what one teacher had to say:

“Yes. I have already been trained on how to use ICT to teach mathematics, although it was too short. The training was facilitated by the government through the Ministry of Education. Only two of us (teachers) were trained. We are expected to train the rest of the teachers in the school.” [teacher in 5th interview]

This finding shows that the training provided by the MOE was not sufficient to facilitate effective use of ICT in teaching mathematics. This finding is consistent with Miima (2014) who found that Kiswahili teachers in public secondary schools in Kakamega lacked adequate ICT skills to integrate ICT in their pedagogical practices. Likewise, Florida (2011) found that lack of training in pedagogical use of ICT in teaching was one of the factors hindering implementation of ICT in education in Bomet and Narok counties. The study found that 61% of the teachers had not received any form of training in ICT consequently hindering integration of ICT tools into their classroom practice.
Sandholtz and Reilly (2004) claimed that teachers’ ICT skills were a strong determinant of ICT integration in education. Furthermore, Peralta and Costa (2007) found that teachers’ ICT competence greatly influenced their use of ICT in teaching and therefore it was an important determinant. Likewise, Cubukcuoglu (2013) found that adequate teacher training on ICT use in teaching was a necessity in the effective integration of ICT into classroom practice. As expected, Tondeur et al (2015) found that secondary school teachers in Kenya only commended integrating ICT into their pedagogical practice immediately a professional teacher development programme was initiated. The results further indicated that there was a steady increase in the use of ICT in teaching thereafter the professional development programme was maintained.

4.8.2 Electricity

The study found that lack of electricity was a strong deterrent in the use of ICT in teaching numeracy concepts. Most of the teachers interviewed reported that electricity somehow hindered their use of ICT in teaching mathematics one way or the other. One of the teachers interviewed reported that classrooms in the school were not fitted with electricity save for the computer laboratory. It was therefore impossible to use ICT tools in the classrooms. Here is an excerpt of what she reported:

“In this school there is no electricity installed in the classrooms but in the computer laboratory. Therefore computers cannot be used in the classrooms and can only be used in the computer laboratory; yet there is only one laboratory in the school for all of us to use. Its quite a challenge because one lab can never be enough for all of us.” [teacher in 2nd interview]

Power outages was also reported as a major hindrance to the effective use of ICT in teaching mathematics. The researcher came face to face with this challenge of power
outage in one of the schools. The lesson was just underway when the power simply went off. The teacher noted that it was likely to be restored in the evening implying that there was a likelihood of no power the entire day. The following is a transcription of what the teacher reported:

“Blackouts are a major challenge in the use of computers in teaching. You take your time to plan a good lesson, and there you are, no power. This computer server only uses the mains electricity so if the power goes off, the lesson is off. There is nothing you can do. Its so discouraging after all the effort you invested in the preparation.” [teacher in 3rd interview]

This finding is consistent with Miima (2014) who found that power blackouts was one of the major challenges hindering use of ICT by Kiswahili teachers in public secondary schools in Kakamega County. Likewise, Tondeur et al (2015) found that electricity supply in Kenyan secondary schools was unreliable and therefore it was an obstacle to effective use of ICT in classroom instruction.

It was suggested in the present study that in order to mitigate this problem of power outages, schools should have a stand by generator to supply power in the event of a blackout. Here is an excerpt of what one teacher suggested:

“[The school should procure a standby generator in order to step in whenever power goes off. Otherwise we (teachers) will get discouraged as no one is willing to invest a lot of time and effort into a lesson that is most likely going to fail.” [teacher in 3rd interview]

4.8.3 Computer Laboratory

The study found that the use of ICT tools in teaching of mathematics was mainly carried out in the computer laboratories. Almost all the computer laboratories in the schools were
equipped with the necessary infrastructure to enable teachers use them for teaching purposes. It was however found that most of the classrooms in the schools lacked the necessary infrastructure to facilitate use of ICT tools in teaching. Teachers noted that it was difficult to conduct an effective mathematics lesson using ICT tools in the classrooms. One of the major challenges that teachers reported was the presence of only one computer laboratory in the school meant to be used by all children. For example, one teacher reported that she encountered a lot of frustrations when it came to using the laboratory for mathematics lessons. The following is an excerpt of what she reported:

“There is only one computer laboratory in this school and it’s not easy to get a chance to use it as there is no program put in place to control its usage. It is used on a first-come-first-served basis. Sometimes I plan a lesson to be conducted in the lab only to find it is already occupied. When I come the next time round, I find it locked and the technician who is also the caretaker is no where to be seen. It’s so frustrating.” [teacher in 4th interview]

The sentiment echoed by teachers in the above statement on the limitation caused by one computer laboratory in using ICT cannot be overemphasized. The study found that although many of the schools had only one functional computer laboratory, most of them did not have a program put in place to regulate its use. It was suggested that schools should put in place a timetable to help control the use of the computer laboratory. This finding is in agreement with Kamau’s (2012) finding that there was a general lack of proper programmes for using available ICT facilities in secondary schools in Nyandarua County. This finding is also consistent with Cubukcuoglu (2013) who found that one computer room per school was one of the challenges high school teachers in Northern Cyprus experienced in their use of ICT in teaching. Teachers in this study reported that there was only one computer room in their schools which was mainly used for teaching
ICT skills and therefore other subject teachers did not get much chance to use it. The teachers suggested that an official advance booking system should be put in place to ensure equitable use of the computer room. Cubukcuoglu (2013) asserted that availability and accessibility to the computer room was a major enabler in the use ICT in their teaching.

It was also reported in the current study that some computer laboratories were too small to accommodate some of the classes which were quite large in size. Furthermore, it was reported that some computer laboratories had been converted into a school storage facility. One of the teachers reported that their laboratory was sometimes converted into a unit for storing foodstuffs used in the school feeding programme. Finally, it was reported that some computer laboratories lacked sufficient infrastructure such as enough and socket outlets. One of the teachers interviewed had this to say:

“We have a very good computer laboratory that is quite spacious. It however does not have enough tables and chairs for children’s use. Some of the children are forced to stand the entire period of the lesson. That’s not good for the learners. The charging units are also not enough while some of them are malfunctional. The headmaster has promised to do something about them. For now we are just trying to manage things.” [teacher in 5th interview]

Most of the computer laboratories were also reported to be fitted with furniture suitable for older children. One of the teachers interviewed reported that the computer laboratory in the school was fitted with big tables and benches which made it an enormous task for young children to use. The following is an excerpt of what she reported:

“As you can see this lab is fitted with big benches and tables. So it was never meant for young children to use. The children can’t use computers while seated, they have to use them while standing. Its quite a
cumbersome experience to stand throughout the entire lesson.” [teacher in 1st interview]

The researcher confirmed the teacher’s sentiment that the computer laboratory was actually fitted with large sized tables and benches and that most children were standing throughout the mathematics lesson. The teacher suggested that it would be more appropriate if the school managers considered providing appropriate furniture in the computer laboratory for young children.

4.8.4 Large Class Size or Crowded Classrooms

The study found that in most public primary schools there were large numbers of children in their classrooms leading to crowding as compared to private primary schools which were relatively less crowded. The large number of children in the classrooms posed a great challenge in the adoption and use of ICT in teaching mathematics. One of the teachers interviewed reported that her greatest challenge in the use of ICT in teaching was the use of a small computer laboratory to teach mathematics to a large group of children. The researcher also observed that the computer laboratory was so crowded that it was difficult to move about. When the researcher asked the teacher to point out her greatest challenge in the use of ICT in teaching mathematics, this is what she had to say:

“My class is very large yet our computer laboratory is quite small. Imagine teaching 110 children in that small lab. With a big class like mine, it takes too long to settle them (children) down to serious business. By the time am done settling them down, half of my lesson time is gone. To save time, I would rather they remained in their classroom and I stick to my old teaching techniques on the chalkboard.”[teacher in 7th interview]
This finding corresponds with Tondeur et al (2015) argument that the number of pupils per class in Kenyan schools was among the challenges hindering effective integration of ICT into classroom practice.

4.8.5 Technical Assistance

Teachers need technical assistance in the use of ICTs in their classroom practice. This study found that technical assistance to the teachers in their use of ICTs significantly influenced their use of ICT tools in teaching mathematics. The study revealed that teachers who received technical assistance used ICTs more frequently than their counterparts who did not receive that kind of assistance. Nearly all the teachers who used ICT in teaching mathematics reported that they either had a full time technician in the school who provided both technical assistance to the users as well as maintenance of the gadgets. There were also some teachers who reported that they had a part-time technician available on call whenever his services were required. The following is an excerpt what one of the teachers reported:

“There is a computer tutor in the school who also doubles as a technician. He provides technical assistance to us (teachers). He also helps in the maintenance of the hardware and software. Sometimes when I get stuck and I don’t know what to do next, he comes in handy. I don’t know what I would have done with those gadgets without him being around.” [teacher in 4th interview]

This excerpt echoes the importance of providing technical assistance to teachers to ensure successful adoption and effective integration of ICT into the teaching of mathematics. The issue of recruiting and sustaining a technician was quite an enormous challenge facing schools particularly the public ones. One of the teachers from a public school
observed that it was difficult for the schools to employ a computer technician because there was no vote head for that kind of expense. They suggested that the government should help schools deploy a technician who could serve a cluster of schools. The following is a transcription of what the teacher suggested:

“The government should employ a technician who should be allowed to serve a cluster of schools. He/she should be provided with some efficient means of transport for ease of movement from one school to the next. The technician should be on standby in order to provide prompt technical assistance or maintenance whenever required by the schools.” [teacher in 6th interview]

This finding is consistent with findings from previous studies on factors that influence teachers adoption and ultimate use of ICT in their teaching (Tondeur, 2015; Mbatha, 2014; Karimi, 2012; Buabeng-Andoh, 2012; & AL Harbi, 2014). These studies found that technical assistance to teachers in their use of ICT in teaching was an important determinant. Mbatha (2014) found that teachers normally encounter technical problems in their use of ICT tools in teaching. Yet, Becta (2004) indicated that there was a general lack of technical support in schools. Jones (2004) claims that lack of technical support results in breakdown of ICT tools leading to interruptions in learning. It also makes teachers become frustrated and unwilling to use ICT in their classroom practice (Tong & Trinidad, 2005). Therefore technical support to teachers in the use of ICT in their pedagogical practice in classroom was found to be a necessity (Buabeng-Andoh, 2012).
4.8.6 Malfunctional ICT Devices

Some teachers reported that one of the barriers to successful integration ICT tools into classroom instruction was the malfunctioning of ICT hardware and software. The following is a transcription of what one teacher reported:

“USAID donated about 48 laptops to this school in the year 2008. They helped us to maintain the laptops for a period about five years and then handed over the mandate of maintenance to the school. To date, only two laptops are still functioning while the rest have run down and crushed. We have now received laptops and tablets from the government. Am afraid they will suffer the same fate and run down like the others unless we get a technician to maintain them.” [teacher in 3rd interview]

4.8.7 Availability of Mobile and Portable ICT Tools

Equiping schools with adequate ICT resources is likely to enhance meaningful integration of ICT in the teaching and learning processes. Inan and Lowther (2010) maintain that availability of ICT tools in the classroom has both a direct and indirect influence on teachers’ use of ICT in their teaching. The findings of this study revealed that availability of laptops and tablets in schools significantly influenced their use in teaching mathematics. The study results however did not find statiscally a significant relationship between availability of desktop computers and their use in teaching mathematics. This finding implies that it is more appropriate to equip schools with laptops and tablets for learning purposes rather than desktop computers. The study also found that desktop computers were preferably used for performing office functions while portable devices (laptops and tablets) were preferably used for instructional purposes. Most of the teachers interviewed reported that laptops and tablets were preferably used
for learning purposes because of their portability and convenience in use. The following is an excerpt of what one teacher reported:

“"We keep the laptops and tablets in those (pointing to a chest of cabinets) movable cabinets. The cabinets have inbuilt charging units. So when we store them in those cabinets, we normally connect them to their chargers so that they get charged overnight. When we come in the morning, the gadgets are fully charged. They can be used without having to connect them to power supply. Sometimes we simply wheel the cabinets to classrooms for use and then wheel back. ”” [teacher in 7th interview]

According to Rheingold (2003) mobile technologies have become more common in educational settings because of their ubiquitous nature of bridging the digital divide. Furthermore they are embedded with wireless technology and therefore do not need to be physically connected to a network in order to access the internet (Rheingold, 2003). It was also reported that it was much more easier for learners to use the tablets in the classroom because they are operated in more or less the same way smart phones are. Most children were able to operate the tablets with a lot of ease. The researcher noted that in almost all the lessons he observed, children tapped on their tablets with a lot of ease and confidence. One teacher reported as follows:

“"Children find it easy and fun to operate tablets. Infact most of them operate them better than some of us (teachers) do. I only trained a few (children) to use the tablets but most of them already knew how to operate the tablets. With desktop computers, you have to train children on ICT skills first before allowing to use."” [teacher in 5th interview]

Calder and Larkin (2016) argue that although laptops and tablets are new on the digital landscape, they offer fresh opportunities to enhance learning experience and student engagement in mathematics. Some teachers lamented that the ICT facilities were not
adequate for successful implementation of ICT integration in teaching and learning of mathematics. Similarly, the researcher observed that some of the schools lacked adequate ICT resources for meaningful integration of ICT into the teaching of mathematics. For example, one of the schools had only ten laptops for the entire school with a population of about 800 pupils to use.

4.8.8 Administrative Support

In most of the schools, the study found that ICT use for the purposes of learning was left at the discretion of the teachers. There was a general lack of school shared vision and policy on the use of ICT tools for teaching and learning purposes. One of the teachers interviewed during the study reported that the decision to use ICT in class was left in the hands of the concerned teacher. There was no policy that required teachers to use ICT in teaching despite the fact that the school was adequately equipped with ICT facilities. She suggested that the schools should at least develop a policy to govern ICT use for teaching and learning purposes. The following is an excerpt of what the teacher reported:

“We have a lot of ICT facilities in this school yet they are rarely used for teaching-learning purposes. They are mostly used for training children in basic computer literacy skills. If the school demanded that teachers use them for teaching, then children will greatly benefit.”[teacher in 5th interview]

This finding corresponds with Cubukcuoglu (2013) finding that encouragement and motivation from the school authorities was an important enabler in the use of ICT by teachers in their teaching. In this study, high school teachers in Cyprus suggested that school authorities should make use of ICT in teaching a mandatory requirement. But according to Cubukcuoglu (2013) pressuring teachers to use ICT may not work, however
making it compulsory while simultaneously providing quality resources would positively encourage teachers to use ICT in their classroom instruction.

Some teachers also reported that their headteachers encouraged and supported their use of ICTs in teaching numeracy concepts. One of the teachers interviewed reported that the headteacher in her school always encouraged her to use ICT devices in teaching mathematics. He also gave her all the necessary support she required in using the devices. The following is a transcription of what she reported:

“My headmaster always insists that I use ICT to teach mathematics. He facilitates training and gives technical support. He personally ensures that ICT devices are in good working condition. It’s so encouraging. Whenever I miss to go to the computer lab, he calls me to ask me why. So I always try not to let him down.” [teacher in 3rd interview]

In agreement with this finding, Buabeng-Andoh (2012) found school technology leadership as a stronger predictor of teachers use of ICT in teaching. Anderson and Dexter (2005) argue that quality leadership and management in schools is crucial in the successful use of ICTs in teaching. In contrast to this finding, one of the teachers interviewed reported that her previous headteacher had not done much in maintaining ICT devices in the school. The researcher observed that most of the computers in that school had broken down. During post-observation interview, the teacher reported that the school had received a new headteacher. The previous headteacher had been transferred to another school. She lamented that the outgoing headteacher had not helped in maintaining the available computers in the school which had been donated by USAID. Here is an excerpt of what the teacher reported:
“Our former headteacher who just got transferred was never interested in these computers. Infact he never ever stepped in here (computer lab). I reported to him that the computers were in dare need of repair but he never bothered. I hope the new headteacher will do something about it.” [teacher in 4th interview]

Ng (2008) argued that transformational leadership with qualities of identifying and articulating a vision, promoting acceptance, providing individualized support, offering intellectual stimulation, providing appropriate model and strengthening school ICT culture could influence integration of ICT use in school. Likewise, Yuen, Law and Chan (2003) found that the school principal was the key change agent in the school.

4.8.9 Time Support

It was reported that more time is required for preparation and use of ICT resources in the teaching of numeracy concepts. Most of the teachers interviewed reported that ICT use in teaching was allocated very little time in the school programme. This is because most schools operate with only one computer laboratory with limited ICT devices that were supposed to be shared by all in the entire school. This implied therefore that only one class could use the computer laboratory at every moment. One of the teachers interviewed reported that her class was slotted to use the computer laboratory for mathematics only once every week which was hardly sufficient. She suggested that the school should allow for more time on the time table for use of ICT in teaching. Here is what the teacher had to say:

“I use the computer laboratory only once per week. This is because there is only one computer laboratory in the school that is supposed to serve all the 16 classes on the school compound. Its quite a challenge. I suggest that the
school should build more computer laboratories and allocate more time for use of ICT in teaching.” [teacher in 6th interview]

This finding is consistent with Mumtaz (2000) and AL Harbi (2014) studies which found that lack of time to explore and prepare ICT resources for teaching was a hindrance to integration of ICT into classroom instruction. Likewise, Mwangi (2014) found that time was a critical barrier that hindered teachers’ use of ICT in their teaching. Teachers reported lack of time schedule on the timetable for use of ICT in teaching (Mwangi, 2014). According to Afshari et al (2009) teachers are sometimes unable to make full use of ICT because they lack sufficient time to explore and prepare ICT resources for a lesson. Furthermore, Siegel (1999) asserts that lack of time for both formal training and self-directed exploration and preparation of ICT tools for lessons was a major barrier in the use of ICT in teaching.
CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary of findings of the study. It also presents the conclusions drawn from the findings. It subsequently presents a discussion of the findings as well as the recommendations for intervention in terms of policy and practice on the use of ICT in teaching numeracy concepts. Finally, it presents recommendations for further research.

5.2 Summary

The first objective of this study was to establish the availability of ICT devices used in teaching numeracy concepts in lower primary schools. The study found that there were a total of 163 desktop computers, 232 laptops and 360 tablets in the 7 primary schools that participated in the study. This implies that the tablets were the most prevalently used ICT devices for instructional purposes. According to Becta (2005) tablets are more popular in schools because of their safe and fast wireless network that facilitates easy access to knowledge and support learning. According to the findings of the study, most of the tablets were found in public primary schools. This state of affairs could be attributed to the on-going distribution of tablets in public primary schools for the implementation of the government-sponsored Digischool Project. Laptops were found to be the second most prevalent ICT gadgets found in the schools followed in the third position by desktop computers. This implies that desktop computers as digital learning devices are being gradually replaced by more portable mobile digital devices such as laptops and tablets.
Other ICT devices that were found in the schools included projectors (12), scanners (7), printers (9), digital cameras (9), interactive white boards, wireless routers (16), and photocopying machines (2). The study revealed that most of the schools were served with internet. This study found that very few schools in Mombasa County were adequately equipped with ICT resources for teaching and learning purposes. Therefore, majority of schools in the county were found to be inadequately equipped with ICT resources for meaningful use in the teaching of numeracy concepts.

On the use of available ICT tools in the teaching of numeracy skills, the study found that majority of teachers in lower primary schools in Mombasa County did not use the available ICT tools in their teaching of numeracy concepts. The findings indicate that only paltry 17% of the teachers actually used ICT in teaching numeracy concepts. This finding implies that 83% of teachers in the county did not use ICT in their teaching of numeracy concepts. The findings further found that only a paltry 4% of teachers used ICT to teach mathematics on a regular basis; while 13% of teachers used ICT in teaching numeracy concepts only once in a while. Overall, the study found that the use of ICT in teaching numeracy concepts was inadequate.

Nonetheless, the study found that ICT tools were mainly used in the teaching of the following basic mathematics concepts in lower primary schools: Pre-number activities, whole numbers, addition and subtraction operations. The tools were also used in teaching measurements particularly the length, mass, money and time. Under the concept lines, the ICTs were used to teach straight and curved lines. Finally, the study found that ICT tools
were also used to teach shapes including rectangles, squares, triangles and circles. According to the study findings, the above mentioned basic mathematics concepts were taught in a game environment using multimedia features of ICT tools.

The study investigated relationship between availability and accessibility to ICT tools and teachers’ use of these tools in teaching numeracy concepts. The study did not find a significant difference in the use of ICT in teaching basic mathematics skills between teachers who had access to desktop computers and those who did not have access to them. This implies that availability and accessibility of desktop computers in schools did not translate into their actual use in the teaching of numeracy concepts. The study however found a significant difference in the use of ICT in teaching mathematics between teachers who had access to laptops and tablets and those who did not. Therefore, availability of laptops and tablets in schools significantly influenced their use in teaching numeracy concepts.

The second objective of the study was to establish whether teachers’ use of ICT empowered them to teach numeracy concepts better. To gain insight into this objective, the researcher collected qualitative data through the use of lesson observations and teacher interviews from teachers who had indicated that they actually used ICT in teaching numeracy concepts. Ten themes categorized under two broad themes emerged from the data coding process. The first broad theme that emerged was effective classroom management. This broad theme included the following sub-themes; that ICT: Is a break from normal routine, facilitates interactive learning styles, increases pupil engagement in mathematics, facilitates classroom activity and improves class attendance. The second
broad theme was cognitive amplification. Under this broad theme the following sub-themes emerged, that ICT: Reduces pupils’ weakness in mathematics, makes mathematics to become attractive, raises pupils’ attention, increases pupils’ concentration, promotes learner autonomy and improves pupils’ memory. These findings imply that ICT is capable of empowering teachers to teach numeracy concepts better.

The third objective of this study was to determine the kind of ICT training and knowledge teachers possessed and how these influenced their use of ICT in teaching numeracy concepts. Data was gathered on the kind of ICT knowledge and skills teachers possessed. The study found that 92% of teachers had at least trained on basic computer literacy skills while only 8% of the teachers had not undergone any kind of formal training on ICT skills. The findings indicate that 25% had received the training from commercial colleges, 27% from teacher training colleges and 38% were trained through workshops and seminars organized by the government and local NGOs.

The study further sought to find out whether teachers possessed Technological, Pedagogical and Content Knowledge (TPACK). TPACK is a specialized kind of knowledge that is deemed necessary for effective and successful integration of ICT in the teaching of numeracy concepts. Literature reviewed showed that mere possession of basic ICT skills was not enough to enable teachers use ICT in teaching numeracy concepts. The study found that about two thirds (64%) of the teachers had no competence on the measures of TPACK. Only a third of the teachers indicated that they had competence in all the measures of TPACK. The study revealed that teachers in Mombasa County were generally low on the scale of TPACK competencies.
The current study also explored the relationship between the teachers’ ICT knowledge and their subsequent use of ICT in teaching mathematics. Pearson Moment Correlation Coefficient technique was utilized to explore this relationship. The study found that teachers’ training on basic ICT skills did not significantly influence their use of ICT in teaching numeracy concepts. This finding is in agreement with earlier finding in this study that despite 93% of teachers having access to ICT tools, yet only 17% of teachers actually used ICT in teaching numeracy concepts. The study however found a significant relationship between TPACK and teachers’ use of ICT in teaching numeracy concepts. Therefore TPACK was found to have a strong positive influence in enabling teachers to use ICT in their teaching of numeracy concepts.

The fourth objective of this study was to determine the kind of support teachers received in their use of ICT in teaching mathematics. The study found that there was inadequate support to teachers in the use of ICT in teaching numeracy concepts. The findings of the study indicated that most of the lower primary schools in Mombasa County did not have a standby technician to give teachers technical support in their use of ICT in teaching. Only 20% of the teachers indicated that their schools had a standby technician in the school. The study also found that only 37% of the teachers received technical support in their use of ICT in teaching mathematics. Further, the study findings revealed that majority of the teachers did not receive support in pursuing professional development courses in their use of ICT in teaching mathematics. The study found that three quarters (74%) of the teachers did not receive any form of support from their schools in pursuit of professional development courses on the use of ICT in teaching. Only a quarter of teachers indicated that they were supported by their head teachers in pursuing
professional development courses in relation to the use of ICT in teaching numeracy concepts.

The study further explored the relationship between teachers’ technical and professional development support and their use of ICT in teaching numeracy concepts. This relationship was explored using One Way ANOVA technique at 0.05 significance level. The study found a significant difference in the use of ICT in teaching numeracy concepts between teachers who received technical support and those who did not receive support. Furthermore, the study found a significant difference between teachers who received support in their course of professional development and those who did not receive that kind of support. This finding implies that providing teachers with technical support as well as supporting their professional development course positively influenced them to use ICT in teaching numeracy concepts.

The fifth objective of the study was to establish whether teachers’ use ICT in teaching numeracy concepts influenced teachers’ pedagogical practices. Data was analyzed qualitatively in order to identify orchestration techniques utilized by teachers in teaching numeracy concepts using ICT tools. Four orchestration techniques were identified through theory-driven and data coding process. The four orchestration techniques include the following: Technical-demo, explain-the-screen, link-the-screen and discuss-the-screen techniques. The study found technical-demo orchestration as the most widely used technique by the teachers in their teaching of numeracy concepts.

The sixth and final objective of this study was to establish factors that determined or hindered the use of ICT in teaching numeracy concepts. To gain insight into these factors,
both quantitative and qualitative data was captured from the teachers. Eight factors emerged as key determinants of use and non-use of ICT in teaching mathematics. These factors included: teacher training, electricity, computer laboratory, class size and technical assistance. Availability of mobile and portable ICT devices, administrative and time support were also found to be factors determining the use of ICT in teaching numeracy concepts.

5.3 Conclusions
This study explored the extent to which teachers use ICT in their teaching of numeracy concepts in lower primary schools. It also sought to establish factors that determine teachers’ use of ICT in teaching numeracy concepts. The study was able to draw three main conclusions as follows: First, based on the finding that only 17% of teachers used ICT in teaching numeracy concepts and that only 4% of the teachers used it on a regular basis; it is logical to conclude that teachers’ use of ICT in teaching of numeracy concepts in lower primary schools in Mombasa County was inadequate.

Secondly, the finding revealed that majority of the schools were not adequately equipped with ICT resources for teaching-learning purposes. The study also found that most of the schools had only one computer laboratory which was supposed to be shared by all. It is therefore apparent that the schools that participated in the study were not adequately equipped with the necessary ICT resources for meaningful use in teaching numeracy concepts. The study also revealed that availability of laptops and tablets in schools subsequently translated into their use in teaching numeracy concepts. This conclusion implies that school managers could enhance use of ICT in teaching mathematics by
equipping their schools with laptops and tablets. Availability of desktop computers in schools did not significantly influence use of ICT in teaching numeracy concepts. Thirdly, the findings confirmed that teachers’ professional development on use of ICT in teaching was a vital ingredient in the successful use of ICT in teaching mathematics. The study found that despite 93% of teachers having been trained on basic ICT skills, only 17% of the teachers actually used ICT in teaching mathematics. It is thus logical to conclude that mere acquisition of basic ICT skills by teachers was not adequate in enabling them to integrate ICT in their teaching of numeracy concepts.

The study findings further revealed that effective use of ICT in teaching mathematics requires specialized kind of knowledge referred to as technological, pedagogical and content knowledge (TPACK). TPACK comprises good understanding on how best mathematics concepts could be imparted using ICT as well as pedagogical techniques that utilize ICT tools in constructive ways to effectively teach mathematics. It is therefore logical to conclude that teachers’ professional development efforts should mainly focus on imparting TPACK to teachers rather than merely equipping them with basic computer literacy skills.

5.4 Recommendations

Based on the study findings and conclusions, a number of recommendations are hereby suggested for policy intervention, improvement in practice and further research.
5.4.1 Recommendations for Policy Intervention

i. The findings of the study revealed that ICT devices were not adequate in the schools to facilitate effective and meaningful integration of ICT into the teaching and learning of mathematics. It was also found that laptops and tablets were more suitable for teaching-learning purposes as compared to desktop computers. Based on this finding, there is need therefore, for the government and school managers to increase the number of laptops and tablets in school. In implementing this, the target should be one-child-one-laptop or tablet policy to ensure that there are adequate ICT tools in schools for meaningful integration into the teaching – learning processes. This policy should be enforced in all public and private primary schools.

ii. The findings of the study further revealed that: a) It was beneficial for teachers to use ICT in their pedagogical techniques of teaching mathematics; b) use of ICT influenced teachers’ pedagogical techniques in teaching mathematics better. c) Some teachers used ICT in their classroom practice because their school policy required them to do so. d) There was a general lack of school policy on the use of ICT in teaching. There is need for the Government of Kenya to put in place a policy measure that makes it a requirement for all teachers to use ICT in their teaching.

iii. Teachers’ proficiency in pedagogical use of ICT in teaching mathematics was found to be a major determinant in the enhancing or hindering its use. The Kenyan Government should develop a policy framework that makes it a
requirement to incorporate pedagogical use of ICT in all teacher training courses in colleges and universities.

5.4.2 Recommendations for Intervention on Practice

i. The study found that although majority of the teachers were trained in basic ICT skills, only a few had integrated ICT into their classroom instruction. The study further found that majority of them lacked knowledge on pedagogical use of ICT in teaching. Those who had that kind of knowledge had little competence in pedagogical use of ICT. The Government of Kenya through the MOE and KICD should put in place a robust programme for training and retraining of teachers in pedagogical use of ICT in teaching. The training programme should target all teachers both in public and private school. The study found that the government had organized seminars and workshops that had only targeted teachers from public primary schools.

ii. There is need for school managers to work collaboratively together in order to establish interschool and intraschool communities where teachers would meet on regular basis to share ICT knowledge, skills and experiences. This should aim at improving their level of competence in the pedagogical use of ICT in classroom instruction.

iii. Availability of only one computer laboratory in most of the schools was found to be one of the major obstacles teachers faced in their use of ICT in teaching mathematics. The study also found that there was general lack of school policy on the use of the computer laboratory as a learning resource. There is therefore need
for school managers to increase the number of computer laboratories in the school to increase access to ICT tools. There is also need for schools to develop and use of a time-table to control the use of the facility in order to optimize its use.

iv. The study also found that the number of ICT devices in most of the schools were not adequate to facilitate effective implementation of ICT integration into classroom instruction. There is need for school managers particularly those in private primary schools to purchase more ICT tools with more emphasis laid in purchasing laptops and tablets. These gadgets were found to be more suitable for learning purposes.

v. Finally, the study found that technical assistance to teachers in their use of ICT in teaching was a key determinant yet it was generally lacking in most schools. There is need to deploy a standby technician to be available to support teachers in their use of ICT in teaching. The technician could be employed on either part-time or full-time basis depending on the school needs and capacity to maintain them.

5.4.3 Recommendations for Further Research

i. The current study focused on teachers in its collection of data on the use of ICT in teaching mathematics in the lower primary. There is therefore need to conduct a study that targets school teacher trainers, principals, parents and ICT experts in order to get their views and gain more insight on the use of ICT in teaching mathematics and other school subjects.

ii. Teachers teaching in lower primary schools are expected to teach all subjects. This study only focused on the use of ICT in teaching mathematics. There is
therefore need to conduct further studies that focus on other curriculum areas besides mathematics in order to get insight into how ICT is harnessed to enhance teaching of these curriculum areas, for example the use of ICT in teaching of language, science, social studies, creative and religion.

iii. This study only targeted teachers for interview on the use of ICT in teaching mathematics. Data on children’s voices on how ICT enhances their learning of basic mathematics concepts was not captured in the study. There is therefore need for future studies to capture data on children’s voices on how ICT enhances learning of mathematics in lower primary schools.

iv. This study employed the use of interview, observation and questionnaire techniques to collect data on the use of ICT in teaching mathematics. Future studies should employ the use of Focus Group Discussion to obtain detailed information about personal and group feelings, perceptions and opinions on ICT use in the teaching-learning process.
REFERENCES


APPENDIX I

TEACHER QUESTIONNAIRE (TQ)

To the esteemed teacher:

This questionnaire is part of my PhD study on your use of ICTs in teaching mathematics that I am currently undertaking at Kenyatta University. Please omit your name and that of your institution. Respond to ALL the items as clearly and accurately as you can. Your professional experiences and opinions are crucial to helping us understand the use of ICTs in teaching mathematics from the teacher’s point of view. I greatly appreciate your taking time to complete this questionnaire. If you tick “consent not granted,” then return the questionnaire unfilled. Thanks for your cooperation.

*Instruction: Please tick in the box where appropriate.*

I hereby do grant my consent to participate in this study [ ] Consent not granted [ ]

**Part A: Teacher’s demographic characteristics**

Please answer all the following questions in the space provided to the best of your knowledge

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>What's your gender?</td>
<td>[ ] Male [ ] Female</td>
</tr>
<tr>
<td>2</td>
<td>What's your age?</td>
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<tr>
<td>3</td>
<td>What's your level of education?</td>
<td>[ ] Certificate [ ] Diploma [ ] Degree [ ] Masters</td>
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<tr>
<td>4</td>
<td>How many years have been employed as a teacher?</td>
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<tr>
<td>5</td>
<td>Do you have access to a computer at home?</td>
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<tr>
<td>6</td>
<td>Do you have access to internet at home?</td>
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<tr>
<td>7</td>
<td>What is the number of years of your experience with ICT?</td>
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<tr>
<td>8</td>
<td>Have you undertaken any ICT training programme?</td>
<td>[ ] Yes [ ] No</td>
</tr>
</tbody>
</table>

198
Part B: Availability of ICT resources

Define availability of ICT equipment in your school. Tick (√) in the box to indicate your choice

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not available</th>
<th>Available in computer lab and resource centre</th>
<th>Available in the classroom</th>
<th>Available in the office</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Desktop computers</td>
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<tr>
<td>2 Laptop computers</td>
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<tr>
<td>3 Tablets</td>
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<tr>
<td>4 Projectors</td>
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<tr>
<td>5 Scanners</td>
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<tr>
<td>6 Printers</td>
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<tr>
<td>7 Digital cameras</td>
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<tr>
<td>8 Interactive whiteboards</td>
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<tr>
<td>9 Mathematics software</td>
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<tr>
<td>10 Internet</td>
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</table>
Part C: Use of ICT in the teaching of mathematics

Please respond to the following statements in terms of your current use of ICT resources in the teaching of mathematics. Tick (✓) in the box to indicate your choice for each statement.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Never</th>
<th>Once per term</th>
<th>Once per month</th>
<th>Once per week</th>
<th>A few times a week</th>
<th>Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 I use ICT (computers, laptops, projectors, tablets) during teaching and learning of numeracy concepts</td>
<td></td>
<td></td>
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<tr>
<td>2 I use ICT primarily to supplement my teaching and reinforce specific math concepts</td>
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<tr>
<td>3 I use ICT to promote children’s creativity and innovative thinking about numbers, patterns, shapes and space</td>
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<tr>
<td>4 I use ICT to teach number operations such as addition, subtraction, division and multiplication</td>
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<td>5 I use ICT to engage children in numeracy activities that require them to analyze information, think creatively, make predictions and draw conclusions</td>
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<td>6 I use ICT to search for more information on numeracy concepts internet, download and use e-textbooks</td>
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<td>7 My learners apply numeracy concepts learnt in class to real life problems using ICT</td>
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</tbody>
</table>
I use ICT to produce multimedia effect such as pictures, sound and games in enhancing development of mathematics concepts

I use ICT to promote interaction and discussion during math sessions

### Part D: Technological Pedagogical and Content Knowledge

Please for each item in this section; select only one option that best describes you.

<table>
<thead>
<tr>
<th>Statement</th>
<th>No Competence</th>
<th>Little Competence</th>
<th>Not Sure</th>
<th>Moderate Competence</th>
<th>Much Competence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I can update my instructional material basing on numeracy needs of learners using ICT</td>
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<tr>
<td>2. I can use ICT to determine children’s numeracy needs during lesson planning</td>
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<td>3. I can use ICT to develop numeracy activities based on learners’ needs to enrich the teaching and learning process</td>
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<td>4. I can implement an effective classroom management during mathematics lesson using</td>
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<tr>
<td>ICT tools</td>
<td>5</td>
<td>I can apply instructional approaches and methods appropriate for individual differences in numeracy using ICT</td>
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<td></td>
<td>6</td>
<td>I can develop appropriate assessment techniques and tools for math using ICT</td>
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<tr>
<td></td>
<td>7</td>
<td>I can update my mathematics knowledge and skills using ICT</td>
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<tr>
<td></td>
<td>8</td>
<td>I can update my technological knowledge and skills using ICT</td>
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<td></td>
<td>9</td>
<td>I can be able to use ICT-based communication tools such as facebook, whatsapp, twitter, email and forums to enhance learning of math concepts</td>
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</tbody>
</table>
Part E: Management and Support in ICT use

Select the option that best describes your situation. If uncertain, then simply select ‘not sure’ option.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Clearly No</th>
<th>Mostly No</th>
<th>Not Sure</th>
<th>Mostly Yes</th>
<th>Clearly Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  There is a technician in the school</td>
<td></td>
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<tr>
<td>2  The school provides adequate technical support for ICT use teaching and learning</td>
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<td></td>
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<tr>
<td>3  The school provides adequate maintenance of ICT facilities in use for teaching and learning</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>4  There are adequate opportunities for professional development for teachers to use ICT in teaching</td>
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</tbody>
</table>
APPENDIX II

Teachers’ Interview Protocol (TIP)

1. What informed your choice of ICT in teaching numeracy concepts?
2. What difference does it make to teach numeracy concepts with and without ICT?
3. How often do you use ICT to teach numeracy concepts?
4. What strategies do you use in teaching numeracy concepts when ICT is involved?
5. What mathematics activities and topics have you developed using ICT?
6. What ICT skills do you possess? Where did you receive your training?
7. What kind of support does the school provide in use of ICT in teaching?
8. What factors have enabled your successful use of ICT in teaching numeracy concepts?
9. What factors have hindered the effective use of ICT in teaching numeracy concepts?
APPENDIX III

RESEARCH CONSENT FORM

My name is Mr. Benard Liteli Ashiono, a PhD student from Kenyatta University. I am conducting a study on “use of technological tools and resources in the teaching and learning of children in lower primary schools in Mombasa County.” The information shared will be used in writing my PhD thesis.

**Procedures to be followed**
Participation in this study will require that I ask you some questions or you fill a questionnaire. Your participation in the study is voluntary. You may ask questions related to the study at any time. You may refuse to respond to any questions and may stop the interview at any time without any consequences whatsoever.

**Discomforts and risks**
Some questions may make you uncomfortable. If this happens, you may refuse to answer these questions if you so choose. The interview/questionnaire may take approximately 30–40 minutes of your valuable time.

**Benefits**
If you participate in this study, you will help us to learn how to effectively integrate and use technology in classroom to improve the quality of teaching – learning in primary school.

**Confidentiality**
The interviews and information recorded on the questionnaires will be kept private in a locked cabinet for safe keeping. Your names will not be recorded on the questionnaires to protect privacy.

**Contact information**
If you have any questions you may contact the research supervisors; Dr. Teresa Mwoma on 0726 392781 or Dr. Catherine Murungi on 0725 762527 or the Kenyatta University Ethical Committee Secretariat at chairman.kuerc@ku.ac.ke, secretary.kuerc@ku.ac.ke, ercku2008@gmail.com.
Participant Statement of Consent
The above information regarding my participation in the study is clear to me. I have been given a chance to ask questions and my questions have been answered to my satisfaction. My participation in this study is entirely voluntary. I understand that records will be kept private and that I can leave the study at any time.

Name of participant………………………………………………..

Participant’s signature………………………………Date …………..

Researchers Statement of Consent
I, the undersigned, have explained to the research participant in a language that s/he understands, the procedures to be followed in the study and the risks and benefits involved.

Name of researcher …………………………………………………..

Researcher’s signature ………………… Date ……………..
APPENDIX IV

RECOMMENDATION TO NACOSTI FOR RESEARCH AUTHORIZATION

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 8710901 Ext. 57330

OUR REF: E83/27828/13
Date: 9th August, 2016

The Director General,
National Commission for Science, Technology & Innovation,
P.O. Box 30623,
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR M. BENARD L. ASHIONO REG. NO. E83/27828/13

I write to introduce Mr. Ashiono who is a Postgraduate Student of this University. He is registered for Ph.D. Degree programme in the Department of Early Childhood Studies in the School of Education.

Mr. Ashiono intends to conduct research for a Ph.D. thesis entitled “Determinants of Information and Communication Technology Integration in Development of Mathematics Concepts in Lower Primary Schools in Mombasa County, Kenya”.

Any assistance given will be highly appreciated.

Yours faithfully,

MRS. LUCY N. MBAABU
FOR: DEAN, GRADUATE SCHOOL
APPENDIX V

RESEARCH AUTHORIZATION LETTER

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241346, 3310873, 3218420
Fax: +254-20-318245, 318249
Email: dgi@nacostil.gov.ke
Website: www.nacostil.go.ke
When replying, please quote
Ref: NACOSTI/P/16/27492/13782

Date: 4th October, 2016

Benard Litali Ashiono
Kenyatta University
P.O. Box 43844-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on
“Determinants of Information and Communication Technology in
development of mathematics concepts in the lower primary schools in
Mombasa County, Kenya,” I am pleased to inform you that you have been
authorized to undertake research in Mombasa County for the period ending
3rd October, 2017.

You are advised to report to the County Commissioner and the County
Director of Education, Mombasa County before embarking on the research
project.

On completion of the research, you are expected to submit two hard copies
and one soft copy in pdf of the research report/thesis to our office.

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:
The County Commissioner
Mombasa County.

The County Director of Education
Mombasa County.
APPENDIX VI

RESEARCH PERMIT
APPENDIX VII

RESEARCH AUTHORIZATION BY THE COUNTY COMMISSIONER

THE PRESIDENCY
MINISTRY OF INTERIOR AND COORDINATION OF NATIONAL
GOVERNMENT

Telephone: Mombasa 2311201
Tel. 0715 040444
Email: maccountyscommissioner@yahoo.com
When Replying please quote:

Ref. no. MCC/ADM.25/243

Deputy County Commissioners
MOMBASA COUNTY

RESEARCH AUTHORIZATION

This is to authorize Benard Litali Ashiceno Permit No. NACOSTI/P/16/27492/13782 from Kenyatta University to carry out research on "Determinants of Information and Communication Technology in development of mathematics concepts in the lower primary schools in Mombasa County, Kenya," for a period ending 3rd October, 2017.

Any assistance given to him will be highly appreciated.

RASHID A. WERE
For: COUNTY COMMISSIONER
MOMBASA COUNTY

C.C.

County Director of Education,
MOMBASA